VOL. XXI.
NO. 510.

SEPTEMBER 2, 1887.

PRICE
FOURPENCE.

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THE ELECTRICAL REVIEW

LONDON: PUBLISHING OFFICE, 22, PATERNOSTER ROW, E.C.—Subscription per annum, Postage inclusive, in Great Britain, 16s. 6d.; to Countries in Postal Union, of the first class, 21s. 8d.; of the second class (Aden, India, Persia, &c.), 23s. 10d.—New York: D. Van Nostrand, 23, Murray Street, and 27, Warren Street. Paris: Madame Veuve J. Boyveau, Librairie Etrangère, 22, Rue de la Banque. Berlin: A. Asher & Co., 5, Unter den Linden.

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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XXI.—NO. 510.

AN ARBITRARY CENTRAL STATION LIGHTING COMPANY.

ELECTRIC lighting from central stations would not make much headway in England, we imagine, even if the road were in all other regards quite clear, under the conditions which a Paris company is imposing upon its customers. In the first place the Société Française de l'Eclairage Electrique charges for the fittings it supplies at the rate of 16s. per lamp, and will permit consumers to employ none other. The charge for current is 1·92d. per ampère per hour, and a light equal to 33 candles per ampère is guaranteed. For inspection and upkeep of fittings there is an annual charge of 3s. 2d. per lamp. Renewals have to be paid for by the consumer at the rate of 8s. per lamp per annum for lamps "spontaneously extinguished," and 4s. each for all others. Meter hire involves a payment varying from 2s. a month for a current of 10 ampères to 8s. 9½d. a month for 100 ampères. The consumer must not alter the fittings, and must be prepared with his payments monthly with unfailing regularity, or, within five days, his supply will be cut off; he has not even the right of challenging the readings of the meter, a right which, according to a recent decision, English gas consumers possess and may successfully exercise. He must enter into a five years' agreement, and if he omits to give six months' notice before the expiration of the five years, it is to be held as agreed that the contract is renewed for another period of five years. A deposit of 4s. per lamp is retained until the five years have elapsed, and if the company ceases lighting, the consumer is to have no right of action for damages, the conductors, however, remaining his property. It is easy to see that these restrictions and conditions might be made a source of frequent unpleasantness and dispute, but the absolute need for them it is not so slight a task to discover. The conditions, indeed, seem to be designed with the purpose of safeguarding the company to the utmost possible limit, whilst the consumer is charged to what strikes us as being an extravagant extent and is left scarcely a loophole, whatever may be the conduct of this arbitrary electric lighting company. It is only right, however, to add that the consumer may be graciously relieved of his bargain—happy he if he finds it a good one!—if he gives up his business or changes his domicile—but not if he sells his business. English contracting firms and companies would gladly embrace opportunities of supplying light at, if we mistake not, much lower charges and upon conditions far less onerous to the consumers than those imposed by the proprietors of the central station in the Boulevard Montmartre.

A REVERIE.

THE Science of History teaches us to regard man of every age as the product of his precedents. We of to-day are the heirs of all the ages past, our science has developed from the superstitions of mediæval times and our intelligence from the ruder instincts of a remote savagery. As intelligence grows we wrest from capricious demons the power of governing the universe and seek to establish its development according to the Reign of Law. But all our progress in thought is only accomplished gradually, though in an unbroken line, of psychical evolution. Such is the teaching of history. Progress is continual development, but, notwithstanding the overwhelming grandeur of the conception, there are times when the mind falters in according it full credence. Now and again, soaring above the intellect of the age, shining transplendently —star of his century—rises a genius whose thoughts, stamped with originality, make the thoughts of other men tarnish in the presence of their lustre. Such an one we have found. France, described by Hugo as the "Saviour of Nations," has given him birth, and in d'Humy we gladly hail the saviour of his century. Monsieur d'Humy has invented a primary battery. Inventive genius in this direction has been lacking in recent years, and it may be that our readers have forgotten the very name of battery. Let us hasten to assure them that it is not, as might be implied, dedicated to the arts of war, but entirely devoted to the arts of peace. Its office is not to distribute carnage and death, but electricity. 'Tis not to light the battle field with the lurid blaze of destruction, but London clubs with the subdued softness of the glow lamp. Its function is not to make widows and orphans, but happy and contented citizens. And this great invention which heralds the dawning of a new epoch is simplicity itself. An outer jar, an inner pot, a plate of iron, a hollow carbon, and lo! one cell (? *sell*) of the battery is complete. Multiply these cells a hundredfold and the effects are multiplied in the same ratio. Verily we have here a power the effect of which, on the fate of Nations or on the destiny of Empires, it is impossible to estimate. . . . . It was our intention to go on in the strain for some pages, *a la Morning Post*, our desire to emulate such a high toned journal having been aroused by an article in its issue of the 25th ult. The article referred to was entitled "Electric Lighting in London," and dealt mainly with the d'Humy battery, but a more glaring revelation of journalistic incompetence it has never been our lot to witness. In many cases the *Morning Post* represents ideas worthy of the feudal ages, but the Editor must be a veritable Rip Van Winkle to allow the antiquated rubbish of this article to be printed. We are glad to accord to the paper in question the palm for describing a fashionable wedding and for hitting off to a nicety the exact tint of the gloves worn by the bride or the gown by her mother, but when it leaves its legitimate gossip to delude the British public about things it knows nothing about, it is high time for some one to interfere. As it is, the *Morning Post* has been "sold," and by a primary battery resurrectionist.

WE are much gratified to perceive that the Philadelphia trials of Mr. Reckenzaun's system of motors and accumulators for tramcars are winning the favour of the representatives of some of the great street railway companies of the States. A number of these on August 15th witnessed a trial trip from Mr. Wharton's yard, and expressed their entire satisfaction with the system. It is no secret that the railway companies have for a long time been looking about them in the hope of discovering some more satisfactory means of working their lines than by means of horses; electricity in various forms has, during the last year or two, attracted a great deal of notice, but it is only within the last few months that the use of secondary batteries for the supply of current to the motor has been demonstrated. Mr. Julien has been at work in New York and Mr. Reckenzaun at Philadelphia upon practically the same problem. One of the tramway presidents who were present at the trial in Philadelphia on August 15th, who had previously been rather an opponent than a believer in electricity for street locomotion, acknowledged that he believed that the system would work, and said he thought very well indeed of it. In the inevitable interview with a reporter he said:—"The trial yesterday was very successful. It was possible to do almost anything with the car. The speed could be easily regulated so as to make it run fast or slow as desired, and a speed of 12 miles an hour could be maintained. It is very simple in construction. I have never been altogether favourably impressed with the electric motor until now. I think the storage battery system is a great improvement over all others. As soon as we are satisfied that electric motors are the best substitutes for horses we will introduce them." This last statement is full of encouragement to the electricians in America who are following the subject of electric locomotion, for it assures them that there exists amongst tramway people there none of that reluctance to forsake ancient methods, however unsatisfactory, which is so strong a characteristic of the Britisher.

THE two or three thunderstorms which have occurred during the last fortnight—a day or so more than the fortnight really—have caused the death, so far as we can make out, of 11 persons in this country. Four of these were killed in the London district, three near Birmingham, one at Buxton, one near Rotherham, one at Mende, and one at Bolton. An astonishing fact in connection with these lightning fatalities is that in more than one instance death was the result of the victim's taking shelter underneath a tree. The danger of this proceeding, it would be thought, has been so constantly pointed out for the past 50 years and more, that no person of any years can possibly have failed to yet become aware of it. There is no more dangerous position during a thunderstorm than immediately underneath the boughs of a tree and in close proximity to the trunk; whilst there is scarcely any safer locality than at a few feet distance from a tree.

THE pamphlet in which the Institution of Civil Engineers expresses itself desirous of obtaining papers upon a long list of subjects should convey a lesson to the Society of Telegraph-Engineers and Electricians. That society has it in its power to become of some use to the profession by striking out from the somewhat narrow path which it has hitherto followed and endeavouring to attach to itself the brains and genius devoted to the elucidation of electrical problems. Why should it allow itself to be outdone in its own domain by an institution which, although a vastly important one, is not specially concerned with electrical subjects? We desire to see the Society of Telegraph-Engineers and Electricians taking its proper position as *the* society for electricians, and we think it is possible to do so if only a little enterprise combined with a little common sense be exercised.

THE Address delivered on Wednesday evening by Sir Henry Roscoe, F.R.S., to the members of the British Association now assembled in Manchester, is of a nature which is hardly suitable to our columns, and we therefore refer any of our readers who may be desirous of perusing an address, unavoidably confined within narrow limits, to the daily press and to journals such as *Nature*. The meeting bids fair to be the most successful which the Association has yet held. The number of members has already reached the unprecedented figure of 3,568, and it is not unreasonable to expect that it will have risen to 4,000 before the week is out.

SIR HENRY ROSCOE gives the following anecdote respecting the great chemist, Dalton, who enunciated the laws of chemical combination by weight:—"As regards the size and shape of the atoms, Dalton offered no opinion, for he had no experimental grounds on which to form it, believing that they were inconceivably small and altogether beyond the grasp of our senses aided by the most powerful appliances of art. He was in the habit of representing his atoms and their combinations diagrammatically as round discs or spheres made of wood, by means of which he was fond of illustrating his theory. But such mechanical illustrations are not without their danger, for I well remember the answer given by a pupil to a question on the atomic theory: 'Atoms are round balls of wood invented by Dr. Dalton.'"

IN our issue of July 22nd, we fully described and illustrated the system of the Writing Telegraph Company, of New York. The company has now opened offices in London, and is giving public demonstrations of the system at the American Exhibition. A few days since an opportunity was afforded us of carefully examining the instruments used and the mode of operating them, and in every respect the merits of the invention impressed us most favourably. The simplicity of the system is very striking, the operator being able almost without any practice to send a message that is sufficiently distinct to be read, though, of course, after a little experience the writing possesses increased legibility and is accomplished with greater ease and speed. The writing telegraph while answering all the purposes of a telephone, possesses advantages over that apparatus in several respects, inasmuch as it operates silently and secretly, and though several persons may be present in a room while the message is being sent or received, no one can know what its contents are without going to the instrument to read the message as it passes from the pen. The instruments, as will be seen from our description already referred to, are remarkably simple and would probably in practice be less troublesome than telephones while the accuracy of the message transmitted is indisputable, the sender having a fac simile record of the writing received at the other end.

THE ROYAL JUBILEE EXHIBITION, MANCHESTER.

EXHIBITS.—CONDUCTORS.

To whatever branch of the practical applications of electricity we may direct our attention, we necessarily find one special class of manufacture ever present, and, though varying in its form and material as the requirements of the subject necessitate, the "conducting wire" is essentially an indispensable feature. The manufacture of conducting wires, bare or insulated, has for many years been carried to a high state of perfection in this country, and the export trade has always been one of considerable magnitude, the excellence of our conducting wires, whether for land or submarine telegraphy, having long been recognised. In the present Exhibition the examples shown, although exhibitors are not so numerous as they might be, sustain the reputation of the several manufacturers.

At stand 564 Messrs. Richard Johnson and Nephew, of Manchester, exhibit samples of their well-known qualities of telegraph and telephone wire. These are, however, almost lost in the very large trophy exhibited by them in the form of a temple made up of the raw material to the finished articles, showing ingots, blooms, drawn wire, plain and galvanised, in the various stages of manufacture, and of every grade and description. The size of this exhibit may be imagined, when we state that it weighs about 50 tons and occupies a space of 21 feet × 21 feet, and is stated to be the largest exhibit of wire ever made. A feature of the exhibit is that the whole of the wire is in the same merchantable and commercial condition as it leaves the manufacturers' hands ready for shipment and to go into use. The special class of wires adapted to electrical conductors is the "best best" quality of galvanised telegraph and telephone wires, which comes in well for cheap lines, when first cost is an item, and where work and traffic is light or experimental. Next we have the "extra best best" quality, where something better is required. It is superior to the former in handling, &c., but is inferior to the "special conductivity" which gives all that the "extra best best" gives, with the additional advantage of a very low electrical resistance. This "special conductivity" is followed by a still superior quality in the "extra special conductivity," and in this grade the utmost which can be obtained from the purest iron for electrical purposes is given. The great feature in all these qualities is one for which the firm of Johnson and Nephew have long been celebrated, the great length of pieces which they can give in any size required, without weld or joint, an advantage which is self-evident to all engaged in telegraphy.

Messrs. Johnson also show coils of copper wire of various gauges, and also stranded wires. To those who have not visited the far famed works of the firm at Bradford, Manchester, this exhibit will give a comprehensive idea of the many classes of wire manufactured by them.

Next to the above exhibit, at stand 565, the Whitecross Company of Warrington show a large assortment of wire of various kinds artistically arranged in the form of pyramids, which have a pleasing effect, from the excellent finish of the manufactures. Among those exhibits are shown some telegraph and telephone wire, the former as required by the India Government and Post Office specifications. The India Government wire has, according to specification, a maximum electrical resistance of 13·5 ohms, weight 400 lbs. per mile with a breaking strain of 1,400 lbs., allowing 25 twists in a 6-inch length. The wire for the Post Office specification offers a resistance of from 11 to 11·25 ohms per mile, and has a breaking strain of 1,100 lbs. with 20 twists in a 6-inch length. The single unwelded pieces of No. 8 wire run from 100 to 120 lbs., being practically the weight most conveniently dealt with in the field. Telephone wire of various sizes is also shown. We must not, however, omit to mention a specimen of a wire under test; this is a piece of very fine crucible cast steel wire, to which is suspended a weight of nearly 3 cwt., equal to a breaking strain of 170 tons per square inch. The entire process of manufacture, from puddling, rolling, drawing and galvanising, is carried on at the company's extensive works at Warrington, where we may mention advantage has been derived from the use of the electric light.

At stand 582 Messrs. Walter T. Glover & Co., of Salford, Manchester, exhibit a sample case of the various wires manufactured by Messrs. Frederick Smith & Co., of the Caledonia Works, Halifax, as well as coils of copper wire of various lengths and sizes of hard-drawn and soft wire of high conductivity. A large quantity of the hard-drawn wire is used for telephone as well as telegraphic work. Amongst the coils exhibited is one of No. 18 B.W.G. hard-drawn of high conductivity in one continuous length of over 3½ miles without weld or joint of any kind, the weight of the coil being 134 lbs. There are also shown various coils of high conductivity soft copper which have been tinned. Amongst them various examples of stranded wires may be seen. For line work Messrs. Walter T. Glover & Co. show examples of various sizes of their patent covered wire, braided and served with compound; a very large quantity of this patent prepared wire is used by the Post Office and railway companies, and also abroad. For tunnel or covered work samples of gutta-percha patent covered wire, are exhibited. Some interesting examples are exhibited of telephone cables containing wires up to the number of 100. Amongst this class are patent telephone cables for neutralising the effects of induction, also examples of the progress made in the manufacture of anti-induction telephone cables.

At the exhibit of Messrs. Richard Johnson, Clapham, and Morris, of Lever Street, Manchester (195 C.), which consists of a wire lathing cottage, constructed with fire-proof wire lathing and iron and wire fire-proof cavity partition walls, may be seen some examples of phosphor bronze as well as some specimens of patent silicium bronze for telephone and telegraph work. Examples of lightning conductors may also be seen here, with all the necessary and usual fittings, for the manufacture of which this firm is well known.

For ordinary purposes of telegraph instruments and apparatus and for bells and telephone work, the usual variety of cotton and silk covered wires of every class is shown by Messrs. Walter T. Glover & Co. at their stand, as well as insulated wires of the various kinds in general use.

The manufacture of high conductivity wire for use in electric lighting has now assumed very large dimensions, and this branch of the application of electricity has become of so extended a character that special efforts are being made in many directions for the production of the requirements of this industry. Amongst these requirements the most important are the conducting wires for the magnets and armatures of dynamos, and for the main and branch conducting wires to and from the dynamos. As is well known these assume very diversified forms, from the wire of small size capable of carrying the current for a single 5 C.P. lamp to the very heavy mains carrying 300 or 1,000 ampères. This branch of manufacture is represented in the exhibition by Messrs. Shaw and Connolly, of Manchester, and by Messrs. Walter T. Glover & Co., of Salford.

In Section 3—Chemical and Allied Industries—at stand 707 Messrs. Shaw and Connolly exhibit "electrical wires and cables, including special leads for ship lighting." Amongst the cables we notice a flexible cable, stated to be the largest ever made, which was constructed specially for an Edison-Hopkinson dynamo main to carry 1,000 ampères. Amongst other samples is a superposed laminated wire specially made for the dynamos (Castle dynamo) of the Newcastle Exhibition to increase the E.M.F. by increasing the number of turns in one layer without decreasing the sectional area, and, consequently, the safe current out-put. The wire is wound on edge, and is laminated to give the flexibility necessary for winding a conductor of this shape. The wire was manufactured to the design of Messrs. Holmes & Co. Various other examples of electric light and other wires are shown, of which, we are told, "all the cables and wires shown in this exhibit have been cut from the coils now in actual work, and are not specially prepared to show samples." Of course this is a matter of opinion, but usually when samples are shown they are known to be specially prepared for exhibit, although cut from actual coils, and are appreciated and valued as such.

We must not omit to mention that amongst their exhibits Messrs. Shaw and Connolly show a large number of "electric fittings for installations of electric lighting," including a number of incandescent lamps (in action) mounted in various styles, and also some switches and switch boards. Amongst the lamps is a remarkably brilliant one of 500 C.P. from Messrs. Clarke, Chapman, Parsons & Co., which requires, we believe, as much as 8 ampères of current with an E.M.F. of 110 volts. The various lamps forming this installation exhibit are connected by a cable run to one of the "Manchester" dynamos in the dynamo room used for lighting the Fine Art Galleries.

In the "Machinery at Rest" section at stand 582, Messrs. Walter T. Glover & Co. show an extensive exhibit of the various types of wire used for electric lighting purposes; these include not only a variety of samples but also a quantity of coils ready for actual use, or, as it may be termed, in a "merchantable" condition. That the latter is the case may be judged from the fact that some of the wire originally placed for exhibit was actually requisitioned for lighting purposes in the building itself after the opening of the Exhibition. The samples and coils are described in the catalogue. "Electric lighting: Examples of wire and cable variously insulated for general electric lighting purposes. Concentric cables for electric lighting on board ship and for use with secondary generators or transformers. Multiple cables for secondary generators or transformers. Non-inflammable and other flexible leads for electric lamps." Samples are also shown of their "taper" cable and of a special concentric cable which has been used in connection with the masts in the gardens, carrying 3 Brush arc lights. The feature of this cable is its flexibility. We believe that every form of conducting wire used in the various requirements of electric lighting instruments, dynamos, leads, &c., is exemplified either by sample or actual coil or bobbin at this stand; but Messrs. Walter T. Glover & Co. may well consider that their principal claim as successful manufacturers rests upon the fact that the whole of the heavy main cables and leads for the incandescent electric lighting, and also for the cables for the arc lighting at this Exhibition, was manufactured and supplied by them.

In describing in an earlier number the lighting of the Exhibition, we remarked: "The distance of the several sections from the dynamo room, and the very large number of lamps required, have necessitated the employment of exceptionally heavy conducting wires, formed into cables. These cables have been made in various sizes according to the requirements of the several sections, but they represent a total length of cable exceeding *nine* miles, whilst the bare weight of the copper alone required for the conductors of these cables is calculated to be very nearly *ten tons*. The whole of the conducting wires, including mains, branches and leads for the incandescent lighting, have been manufactured by Messrs. Walter T. Glover & Co., of Salford, Manchester." The cables required for the arc lighting consist principally of Indiarubber insulated 7/16 and 7/18 wires, and as the lamps (512 in all) are spread over the buildings and grounds, a very large amount of this class of wire has been used. A sample board is exhibited showing the various kinds of wire used in the Exhibition installations, which, as we have previously stated, are the largest of their kind yet attempted, and their continued successful working must be considered as reflecting the greatest credit upon the quality and manufacture of the very extensive amount of insulated conductors employed.

EXPERIMENTAL RESEARCHES ON THE ELECTRO-DEPOSITION OF ALLOYS.

By ALEXANDER WATT.

(*Continued from page* 204.)

In the preceding paper I gave the results of some experiments in which I had successfully deposited alloys from solutions of mixed metals, the salts employed being either neutral or faintly acid, but in no case alkaline. Finding that it was the general belief amongst physicists and others that alloys could not be deposited from what I will term *acid solutions*, in contradistinction to the cyanide baths from which alloys have hitherto been obtained, all my experiments were made with mixtures of metallic salts, more or less neutral, the exact condition apparently being of little consequence, since in some cases liquids which were positively acid gave similar results to those in a more neutral condition.

In depositing alloys (brass, for example), from cyanide solutions, it has always been found necessary to employ a current of high E.M.F. to throw down the zinc in due proportion with the copper to form brass of good colour, and where batteries were employed for this purpose, Bunsen's zinc-carbon battery has always been applied by preference. Now it is a somewhat remarkable fact in connection with the experiments which I am now pursuing, that although I preferred to employ my little battery of five cells arranged in series, I successfully obtained deposits of brass when the cells were arranged in multiple arc, apparently showing that a high E.M.F. is by no means necessary to cause the electro-negative and electro-positive metals to deposit simultaneously from acid solutions. In further proof of this I have but to call attention to the fact that the alloys were also obtained without the aid of a direct current at all, that is to say, by the simple contact of a strip of zinc and a strip of steel in either of the mixed metallic solutions, and even by the simple immersion of a strip of zinc, *per se*, in the solution. The late Alfred Smee, in his admirable work, "Elements of Electro-Metallurgy," in reference to the possibility of depositing alloys electrolytically, says: "We have now to discuss the important question whether two or more metals can be reduced at the same time, and whether the metals can be thrown down conjointly with other bodies. This, considering the amazing number of solutions, is a very complex question, and only a general outline of the principles regulating these phenomena can in the present state of our knowledge [1851] be attempted. In entering upon this subject I began by selecting metals far apart in the facility of their reduction by hydrogen; the solutions of the salts of zinc and copper being mixed, only copper was reduced at the negative pole. Without detailing a mass of similar experiments, I shall at once state, as a fundamental principle, an absolute law, derived from a most extensive examination of the voltaic force, that the *voltaic circuit is invariably completed in that mode which offers least resistance to the passage of the force*. That is to say, that if a great variety of roads are offered by which that object may be effected, that the *force*, provided the road be large enough, would pass exclusively through the one offering the least resistance. . . . . As a general principle, to obtain a deposit of two or more bodies on any negative pole, we must use a quantity of the voltaic force, more than sufficient to reduce the elementary substance from the compound most readily decomposed. By the first law regulating the quality of metal reduced by the voltaic current, the metal is always reduced as a sponge when hydrogen is evolved from the negative plate; therefore it would be impossible to obtain a reguline alloy in a solution of any two metals, one of which is above, the other below the evolution of hydrogen, from the particular negative pole we employ in these solutions. . . . . Such is a rough sketch of the principles to be pursued for the reduction of alloys, but at present, practically, I have not reduced a perfect reguline alloy of any metal, though I feel no doubt, by following out the above principles, a person might succeed in attaining his object with some metals by a careful examination of the various salts."

The above words were written by the gifted author at a time when electro-deposition was in its infancy, and no one, up to that period, had done so much as he to popularise the art and render its pursuit comparatively easy to the non-scientific student. The results of my recent experiments, however, appear somewhat antagonistic to the principles above enunciated, concerning the deposition of alloys, for I not only obtained deposits of brass upon steel, which was perfectly reguline, adherent, and readily burnished without stripping, while hydrogen was evolved from the cathode, but also deposits of brass on steel by simple contact of a piece of zinc in many mixed metallic solutions, and also by simple immersion. It is possible that if I had read the foregoing passages in Smee's work before commencing my experiments, I might have been disposed to pursue his line of reasoning, and have endeavoured to follow his precepts—in which case it is doubtful whether I should have succeeded so readily as I did in my first trial, which was really prompted, as before stated, by some observations in Professor Silvanus Thompson's paper on this subject, recalling to my mind certain facts which I had noticed when experimenting upon the electro-deposition of alloys some years ago.

EXPERIMENT VI.—*Acetates of Copper and Zinc.*—In this experiment it was determined to ascertain whether an *acid brassing solution* could be obtained by the *battery process*, as it is termed, and if so, whether the cathode would receive a reguline deposit of brass, as in the former cases. For this purpose about equal parts of commercial acetic acid and water were taken as the solvent solution. A strip of sheet brass was employed as an anode, and a rod of carbon for a cathode. The current was then allowed to pass, when, soon after, the liquid acquired a greenish tint near the anode; the solution was frequently stirred while the electrolysis was proceeding, and at the end of about twenty minutes the carbon cathode was replaced by a steel plate, which became partially coated with a yellow film in less than half a minute. The steel plate was now withdrawn, and the carbon cathode again immersed to allow the solution to acquire a sufficient quantity of the mixed metals to form a practical working bath. In about three quarters of an hour from the commencement of the operation, the bath was found to have become sufficiently charged with zinc and copper to yield a ready deposit of good colour, for on again immersing a prepared steel plate it became instantly coated with a film of brass of a good yellow colour. After a few minutes' immersion the plate was withdrawn and well scoured with silver sand, soap, and water. Finding that the coated metal withstood this treatment without stripping, it was next scoured with the sand and water only, with as much force as possible, to ascertain to what extent the deposit was adherent, and it is not saying too much to state that it required the most severe friction of moist sand, applied without soap, to remove the film, which became dislodged in this brutal fashion after a minute or two, and in a remarkably uniform manner, showing that the alloyed metals had adhered with unusual tenacity. I may here state that so far as I remember I never met with a brass deposit upon any metal so thoroughly adherent. The plate was afterwards reimmersed in the acetate bath, and allowed to receive a fairly good coating. When this had been attained, the plate was withdrawn and scoured with sand and soap as before, and after well rinsing a steel burnisher was applied, when it was noticed that the deposit felt exceedingly soft under the pressure of the tool, and had not the slightest disposition to blister, or in anyway separate from the steel surface beneath. The coating of brass was, therefore, reguline in the highest degree. After coating several other pieces of metal in the same solution, by means of the direct current, the contact method was applied with the result given below.

By Contact.—A strip of steel, in contact with a strip of zinc of the same superficial surface, was immersed in the above bath, and it promptly received a coating of brass on the contact side. The reverse side, with the exception of the edges, was coated with copper only.

By Simple Immersion.—A strip of zinc became coated with a yellow film immediately after immersion; this was promoted by gently moving the piece of metal about while in the liquid.

VII.—The previous results having been obtained with five small cells arranged in series, it was determined to ascertain whether similar results could be obtained with a current of lower tension; with this view the same number of cells were arranged in multiple arc, and some of the experiments with the same solutions repeated. In this case there was a decided tendency for the copper alone to deposit, but when a larger anode surface was exposed both metals deposited in the form of a yellow alloy.

VIII. *Sulphates of Nickel and Copper.*—I may here remark that in all my first experiments I determined to ascertain which of the metals would alloy with *copper* by electrolysis—the red colour of this metal rendering it specially advantageous for the purpose. In the present experiment solutions of the respective salts were first prepared; a small quantity of the copper solution was then poured into the depositing vessel, and to this was added a somewhat larger proportion of the nickel solution. A piece of sheet copper was used as an anode, and a steel plate for the cathode. On immersing the latter a deposit of copper only was obtained. A further addition of the nickel solution was then made, and a fresh cathode immersed, with the same result, namely, copper alone appeared on its surface. A much larger addition of the nickel salt was then given, when, instead of copper alone, a darkish wavy film was obtained, which, when wiped with the finger, exhibited a film approaching the colour of German silver. A still further but moderate addition of the nickel solution was then given, and the next plate, as before, received a wavy dark-coloured film, but it was found that when this was scoured with sand and soap, the coating exhibited positive evidence of an alloy of nickel and copper—not of so good a colour as ordinary German silver however (which contains zinc also), but still an unmistakable alloy.

By Contact.—A strip of steel, in contact with a strip of zinc, was immersed in the above mixed solution, and received a coating of alloy of the same tint of colour as that obtained with the battery current.

By Simple Immersion.—A film of the same character was obtained upon a strip of zinc, by briskly moving it about while in the liquid.

IX. *Tartrates of Copper and Zinc.*—A weak solution of the mixed salts was found necessary to obtain a yellow deposit from this combination. With five cells arranged in series as before, a coating of brass was deposited upon a plate of steel very readily. The deposit was of good colour.

By Contact.—A steel plate, in contact with a strip of zinc, received a yellow coating of brass on the contact side in the above compound solution, copper alone on the reverse side.

By Simple Immersion.—A yellow film, but not of good colour, was obtained on a strip of zinc.

X. *Chlorides of Copper and Tin.*—A weak solution of the mixed salts was employed, because it was found that with stronger solutions a black powdery deposit only could be obtained upon the negative plate. When the liquid had been reduced, by gradual additions of water to a fair depositing condition, there was a slight tendency for the two metals, tin and copper, to go down together, when a large anode surface was immersed. No results of a really satisfactory character, however, were obtained with these mixed salts, either by direct current or by the contact method, while by simple immersion only a dirty yellowish film was obtained upon a strip of clean zinc.

(*To be continued.*)

ON THE THEORY OF THE DYNAMO.

By O. FRÖLICH.

(*Continued from page* 212.)

If we plot out the values of P, obtained at the same speed as a function of $\nu \,.\, w/\mathrm{W}$, the real variable is w/W and the right line from which the constants are determined only appears when w/W almost equal 1. If we put $w/\mathrm{W} = 1 - y$, $y = 1 - \frac{w}{\mathrm{W}}$, where $y = \frac{\alpha}{w}$ and develope the second member of the formula after y, disregarding the higher members then

$$\mathrm{P} = f \,.\, \nu \,.\, \frac{w}{\mathrm{W}} - \frac{\mathrm{P}_{\frac{1}{2}}}{1 - \frac{\alpha}{a} \,.\, y}$$

$$= f \,.\, \nu \,.\, \frac{w}{\mathrm{W}} - \mathrm{P}_{\frac{1}{2}} \,.\, \left(1 + \frac{\alpha}{a} y\right)$$

$$= f \,.\, \nu \,.\, \frac{w}{\mathrm{W}} - \mathrm{P}_{\frac{1}{2}} \,.\, \left(1 + \frac{\alpha}{a} \,.\, \left[1 - \frac{w}{\mathrm{W}}\right]\right)$$

or

$$\mathrm{P} = \left(f + \frac{\alpha}{a \,.\, \nu} \,.\, \mathrm{P}_{\frac{1}{2}}\right) \,.\, \nu \,.\, \frac{w}{\mathrm{W}} - \left(1 + \frac{\alpha}{a}\right) \,.\, \mathrm{P}_{\frac{1}{2}} \,.$$

If we therefore, as in formula (1), put for P :

$$\mathrm{P} = f' \,.\, \nu \,.\, \frac{w}{\mathrm{W}} - \mathrm{P}'_{\frac{1}{2}}.$$

f' and P′ are by no means f and $\mathrm{P}_{\frac{1}{2}}$; but

$$f' = f + \frac{\alpha}{a \,.\, \nu} \,.\, \mathrm{P}_{\frac{1}{2}}$$

$$\mathrm{P}'_{\frac{1}{2}} = \left(1 + \frac{\alpha}{a}\right) \,.\, \mathrm{P}_{\frac{1}{2}}$$

The values which Peukert has obtained agree, indeed, only approximately with these formulæ ; but this is because the right lines in question are only short, not as in a polar tension-curve properly speaking.

The agreement of the observations with the formula (2) which here holds good is satisfactory, but values are obtained for $\mathrm{P}_{\frac{1}{2}}$ which differ from each other by about 5 per cent. I should explain this by the circumstance that the experiments were probably conducted on different days and the condition of the brushes, their lubrication and lead may have somewhat varied. Such differences tell, as will be shown below, not upon the value of f, but on that of $\mathrm{P}_{\frac{1}{2}}$.

That the coefficient α really corresponds with the demagnetising action of the ring currents appears from the series of experiments with a constant current in the limbs of the magnet. If we use the formula, similar to that given above,

$$\frac{\alpha}{\mathrm{P}_{\frac{1}{2}}} = \frac{(\mathrm{E}' - \mathrm{E}) \,.\, f \,.\, \nu}{(\mathrm{J}_a - \mathrm{J}'_a) \,.\, (f \,.\, \nu - \mathrm{E}') \,.\, (f \,.\, \nu - \mathrm{E})},$$

and calculate $\frac{\alpha}{\mathrm{P}_{\frac{1}{2}}}$ from the first and the last observation of each series of experiments, we obtain the values : $\frac{\alpha}{\mathrm{P}_{\frac{1}{2}}} = 0{\cdot}0225$ and $0{\cdot}0302$; the values of $\frac{\alpha}{\mathrm{P}_{\frac{1}{2}}}$ calculated from the remaining observations of this series range between 0·0326 and 0·0344 ; the value of α found from the ordinary observations corresponds, therefore, essentially with the physical signification of this magnitude.

Zickler (*Zeitschrift für Elektrotechnik*, 1887, p. 52) has plotted out current-curves on a Schuckert machine with compound coiling. With a direct winding he obtained $f = 0{\cdot}116$; with a shunt winding he found 0·135 ; in the difference of both values he finds a proof of the dependence of the quantity f on the winding of the limbs.

Here it must be remarked that a useful result can scarcely be expected from the experiments with the shunt winding on direct introduction, since the resistance of this winding is 33 times as large as that of the ring. The current, therefore, rises only to 1·5 ampères whilst with direct winding it amounts to 18 ampères. In this case, therefore, the powers of the machine are not developed.

Nevertheless, here, also, the value of the ring-constant is found more accordant if the increased resistance of the ring is taken into account. If this latter, *e.g.*, is doubled at 600 rotations, the curve of the current with direct winding becomes steeper and we obtain $f = 0{\cdot}130$, almost the same as in the shunt winding.

Here, also, there is no proof that the constant of the keeper depends on the limbs.

STERN.—MACHINES OF KROTTLINGER AND EGGER AND KREMENETZKY.

Stern repeatedly objects that self-induction is disregarded in my representation, and that according to his observations the curve of the current and that of the magnetism depend on the absolute value of the speed.

As for the self-induction it cannot be discussed in my representation, as it depends merely upon empirical laws ; if the increase of the resistance of the ring with the speed is due to self-induction, I take self-induction into account in considering that increase. (See my book, p. 24).

The differences observed by Stern have much resemblance to those of Meyer and Auerbach, and I presume that they may be explained in a similar manner if the changes in the resistance of the keeper are taken into account. In any case these differences cannot be regarded as proved until this variation has been measured and taken into account.

The observations on Egger and Kremenetzky's machine, from which there appears a difference of 2 per cent. from the proportionality between the electromotive force and the magnetism have very little demonstrative power. Differences of several per cent. constantly occur in dynamos on repeating the same experiment ; it should, therefore, first be proved that these differences in two single cases were not accidental, which can be effected only by extensive series of experiments.

GUINAND.—MACHINES OF THE ZURICH TELEPHONE COMPANY.

Guinand (*Elektrotechn. Zeitschrift*, Vol. VII., p. 409), has published a series of measurements carefully executed on the machines of the Zurich Telephone Company with measurements according to my representation. Three different systems of pole pieces were applied to the machine in question. In each system the current curve was determined on direct introduction, the curve of polar tension on introduction as a shunt without exterior resistance, and the behaviour on a separate excitement of the limbs. Further, in one of the systems experiments were made with introduction as a shunt with exterior resistance ; the winding of the limbs was always the same, in direct introduction it was laid parallel by pairs and in shunt introductions one layer behind another.

The curves of the current are very regular, the values of the ring-constants thence inferred agree well ; the value of the limb constant $\mathrm{J}_{\frac{1}{2}}$ grows when the pole pieces are decreased.

The ring-constant may be also calculated from the curves of polar tension without exterior resistance ; I obtain from them the following values for the three different forms of the machine, A, B and C :

A : $f = 0{\cdot}0855$.
B : $f = 0{\cdot}0866$
C : $f = 0{\cdot}0908$.

For the direct winding the value in all the forms is 0·084 ; here, therefore, we have essential agreement.

In calculating the experiments with a shunt circuit and with exterior resistance, Guinand finds differences from my representation. He has, however, not taken into consideration the reaction of the ring, the introduction of which into the formulæ is given in the *Elektrotechn. Zeitschrift* (1886, p. 65).

That this reaction is considerable appears from the experiments made with a separate excitement of the limbs, as also from Guinand's remark that the ring contains much copper. If we take as a basis the value of f found with a direct winding, and calculate the quantities of magnetisation, $\mu \, . \, m_d$ and $\alpha' \, . \, m_d$ according to the formula :

$$\text{M} = \frac{\mu \, . \, m_d \, . \, \text{J}_d - \alpha' \, . \, m_a \, . \, \text{J}_a}{1 + \mu \, . \, m_d \, . \, \text{J}_d - \alpha' \, . \, m_a \, . \, \text{J}_a}$$

whence

$$\frac{\text{M}}{1 - \text{M}} = \mu \, . \, m_d \, . \, \text{J}_d - \alpha' \, . \, m_a \, . \, \text{J}_a$$

there appear for $\alpha' \, . \, m_a$ values which almost amount to the half of $\mu \, . \, m_d$; so that here, also, with an equal current in the ring and in the limbs of the magnet, the demagnetising action of the ring-winding would amount to nearly half the magnetising effect of the winding of the limbs.

If we calculate the shunt experiments according to the formula

$$\text{P} = \frac{f \, . \, \nu}{1 + \frac{a}{w}} - \frac{\text{P}_{\frac{1}{2}}}{1 - \frac{a}{w}}$$

we obtain a rough agreement, but not a satisfactory one ; a good agreement can be reached only for two of the three series given, but not for all, whence I suspect that the position of the commutator had been changed.

As the demagnetising action of the ring is doubtless considerable, the increase of the resistance of the ring with the speed must also be considerable. It cannot be taken into account in the calculations, as the observations furnish no direct means for its determination.

A clear understanding of these experiments cannot be obtained until the variation of the resistance of the ring is considered. The shunt experiments with this winding of the limbs will always have an extreme character, as the ratio of the resistances of the limbs and the ring (13 : 1) is exceedingly small, and never occurs with a proper choice of winding.

LEDEBOER.—CHARACTERISTICS OF DEPREZ.

Ledeboer (*Lum. Electr.*, 1886), cites a passage from my book to the effect that all the curves of the magnetism observed in machines coincide, and that therefore a single curve can be taken as a basis. He declares this proposition incorrect, as it is merely needful to throw "one glance" upon the curves published by Deprez in order to recognise my assertion as untenable.

Ledeboer here overlooks two considerations :—

1. The curve of magnetism which I employ is not equivalent to the characteristic used by Deprez, for in the latter the strength of the current serves as abscissæ, and the E.M.F. (the number of rotations being constant) as ordinates ; in the former certain factors peculiar to the machine have to be ascertained, and the strength of the current and the E.M.F. respectively multiplied by these factors have to be plotted out as abscissæ and ordinates.

2. My representation does not profess to be an accurate reproduction of the curve of the magnetism by the formula throughout its whole extent, but only in the part which occurs in ordinary experiments, especially the "elbow," the last portion of the curve when it bends towards the axis of the abscissæ is excluded from the representation.

I have explained both these points often enough, Ledeboer has hence evidently condemned my representation without understanding it.

The agreement of my representation with the curves of Deprez can be recognised, not by "one glance," but only by calculation. It is simplest to form for every observation the proportion $\frac{\text{J}}{\text{E}}$, and plot it out as a function of J, if the curve as thus drawn forms essentially a right line, it agrees with my formula in its whole extent ; if at least the middle portion forms a ht line, the agreement is at any rate sufficient for actical purposes.

Of the 27 curves published by Deprez, six agree completely with my formula, *i.e.*, the curve *La Lum. Electrique*, Vol. VIII., p. 101, and further Nos. 19, 7, 8, 2, 1 ; the remaining 21 yield in their middle part at least a right line, though some of them certainly for a short extent only ; both in the first and in the second class of curves we encounter about as many Siemens machines as those of Gramme. Whether my representation in the second class does not suit for the practical purposes for which it is intended, would still have to be proved especially by mention of the strengths of currents and the tensions for which the several machines are intended.

In addition I put in a general protest against the accuracy of all these curves ; in part, because they have been executed with measuring instruments which in the present day can scarcely rank as trustworthy ; in part, because as far as the Siemens machines are concerned, I have obtained different results, and lastly, and above all, because the increase of the resistance of the ring with the speed has not been considered.

I do not make this last charge against Deprez, as it falls also upon my earlier curves, and at that time it was disregarded. Ledeboer, on the other hand, must have considered it.

This last point is especially important in old machines which have much copper on the ring. By this correction the characteristic of a directly introduced machine is decidedly raised, and the more the further the point of the curve in question is from the initial point. The inclination of the curve towards the axis of the abscissæ can thus be removed, and the agreement with my formula becomes thus both more accurate and more extensive.

It is therefore possible that the curves of Deprez when corrected will coincide with my formula, even to an extent which exceeds the limits of practice.

INCREASE OF THE RESISTANCE OF THE RING WITH THE SPEED OF ROTATION.

This property of the ring has long been known, and has been theoretically and experimentally examined. It has not, however, been hitherto taken into account in practical experiments on dynamos (including those which I have published) because the occurrence of electromotive forces in the ring occasions difficulties in the experimental determination of this property.

If, on the other hand, we employ the Wheatstone bridge as generalised by me this difficulty vanishes, and in this manner several old and new machines have already been examined at the establishment of Siemens and Halske. Their behaviour will be given below.

The method was applied as follows :—The main current traversed only the side branches of the bridge (see fig. 7), and there were introduced into one branch, the ring of the machine, A (without the limbs), and an instrument for measuring currents, M ; into the other a suitable resistance adapted to strong currents, w, and some accumulators of small resistance, B. The two other branches were formed of a thick wire of copper or nickel silver of about 2 metres in length, roughly graduated. In the diagonal branches were introduced strong resistances and batteries in such a manner that by their application the main current traversing the ring was altered only by a trifling percentage, as was ascertained by the measuring instrument, M. The running contact, C, is formed of a piece of metal with a wooden handle which can be applied in quick succession to any parts of the bridge wire. An astatic mirror galvanometer of little resistance and of great sensitiveness was employed.

The resistance, w, must be known ; we first measure the ring at rest, without and with accumulators, whence the resistance of the latter is determined as far as needful; measurements are then made with the rotating ring. The arrangement is such that the same current prevails in the galvanometer, with and without the application of the running contact.

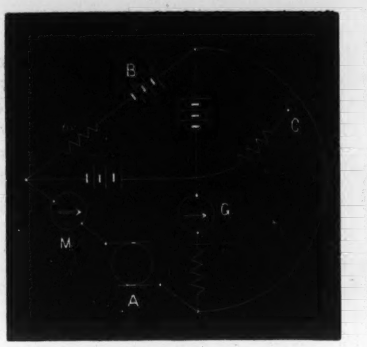


FIG. 7.

The measurements are far from having the exactitude of ordinary determinations of resistance because the current varies continually; the accuracy depends very much on the equable pace of the motor. In the following measurements, which were performed with a small steam engine of not very regular action, the accuracy does not exceed 5 per cent.

We ascertain in the first place that the results obtained in this manner are independent of the strength of the current in the ring; the following numbers hold good for the ring of a *g*F5 machine:—

Number of rotations.	Current in ring.	Resistance in ring.
0	0·35 amp.	0·369 ohm.
0	19·8 ,,	0·369 ,,
620	19·5 ,,	0·426 ,,
—	1·8 ,,	0·439 ,,
—	19·5 ,,	0·426 ,,
—	1·8 ,,	0·430 ,,
—	19·5 ,,	0·443 ,,
—	1·8 ,,	0·434 ,,
—	19·5 ,,	0·439 ,,
1200	18·8 ,,	0·553 ,,
—	3·2 ,,	0·543 ,,
—	18·8 ,,	0·553 ,,
—	3·2 ,,	0·537 ,,
0	20·0 ,,	0·377 ,,
0	0·4 ,,	0·377 ,,

The strength of the current in the ring is selected so that it may be as quiet as possible; to this end it is generally preferable to produce a powerful current by means of accumulators of low resistance, in comparison with which the slight variations of the current produced by the ring may vanish.

(*To be concluded.*)

PRACTICAL ELECTRICAL MEASUREMENT.

By J. SWINBURNE.

(*Continued from page* 216.)

BATTERIES.

VERY little need be said about primary batteries, as with perhaps the exception of the "Upward," they have not yet come into commercial use. In testing a primary cell, the electromotive force on open circuit may be taken by means of an ordinary voltmeter wound with low resistance. This does not really test the cell on open circuit, because most commercial voltmeters absorb considerable power, so that the cell is really giving a current of several ampères. If the cell is small, or if a reading with no current is desired, a potentiometer and standard cell with a local circuit may be used. The various ways of comparing the electromotive forces of cells with great accuracy by the Poggendorff method are given in most text books, so it is unnecessary to repeat them.

When the electromotive force on open circuit is known, the cell may be put to work on resistances, the electromotive force and current being noted from time to time. From these measurements it is easy to see whether the cell does all that is claimed for it.

Secondary batteries have to be tested as to rate of discharge, total working capacity, efficiency, and durability.

If a single cell is taken instead of a whole battery, the results may be somewhat misleading unless some care is taken in drawing conclusions. It is best in bringing out a secondary battery to experiment with single cells; but in ordinary practice the engineer has to deal with complete batteries more than with single cells.

Assuming that the battery is fully formed, the first thing is to make sure it is fully charged. It should be charged till there are clouds of little bubbles coming off both plates even with a small charging current. The specific gravity of the acid should be taken. The acid must be stirred up before dipping the hydrometer in, as otherwise stronger acid may be at the bottom. Some prefer to use weak acid with about one part to 10 of water. The writer believes the acid should be as strong as possible without attacking the spongy-lead plate. When a cell is discharged the acid in the interstices is used up, as the external work is due to the formation of sulphate of lead. The more acid there is available in a given small volume of almost enclosed electrolyte, the larger the output will be, if there is plenty of active coating in contact with it.

The recovery of electromotive force on open circuit, or residual charge as it is sometimes called, is no doubt due to the acid diffusing into interstices where the electrolyte has been used up, that is, where only water is left. Strong acid also gives a slightly higher electromotive force than weak, and lessens the tendency to the formation of basic salts. It has also less specific resistance, and therefore lessens the loss both on charging and discharging.

The higher electromotive force needed on charging is sometimes looked upon as spurious back electromotive force. It is probably due to resistance caused by tiny bubbles of oxygen and hydrogen on the surface and in the insterstices, which increase the resistance enormously by diminishing the section of the electrolyte. There is no spurious electromotive force, at least a cell will charge and discharge slowly within a small percentage of the same electromotive force. If the acid is too strong, the spongy-lead plate may decompose the electrolyte, evolving hydrogen and becoming lead sulphate. Sometimes the spongy-lead plate gives off bubbles continuously even when the acid is not very strong. This is probably caused by some impurity setting up local action. Acid of specific gravity 1·275 can generally be used.

Most of the cheap hydrometers are inaccurate, and it is as well to check the instrument before use. The specific gravity of some acid is measured by the hydrometer. A stoppered bottle of one or two pints' capacity is then weighed carefully with an ordinary grocers' scales; it is then filled with water and weighed again, and then with the acid and weighed. In each case the bottle is filled to the mouth, and the stopper is pushed in, so that there is the same quantity of liquid. The weights of the water and of the acid are taken by subtracting the weight of the bottle, and the specific gravity is got by dividing the weight of the acid by that of the water.

The battery may be discharged at the current given by the makers, or at any rate that does not make the electromotive force drop too much. A curve can be made either with constant current or constant resistance. If the cells are in good order the electromotive force will fall suddenly when the cells are discharged.

If the curve is round, it shows that some of the cells are losing their electromotive force before the others. Each cell should then be tested with the low resistance voltmeter to see which have given out. If any one has given out because it is insufficiently formed the electromotive force may be even reversed, while if it has given out because it was insufficiently charged it may either give too little electromotive force, or may have an apparent back electromotive force while the current from the other cells is being sent through, this electromotive force disappearing when the discharge is stopped, and being, therefore, merely the electromotive force necessary to overcome the resistance of the cell. This method of testing a whole battery is due to Mr. Crompton.

Cells that are bad should be put out of circuit and discharged, so that they may get more thoroughly formed or charged, as the case may be. If this is not attended to the battery will always be kept down to the output of its worst cells.

To find which plate has given out, the writer's method of proof plates is convenient. A little cell consisting of two plates is kept fully charged. Before use it is tested to make sure that it gives its full electromotive force. Then the little negative plate is put in the large cell, and the electromotive force between it and the large positive is taken. This tells if the large positive is right. The large negative is then similarly tested with the little positive.

The spongy lead plate is more often at fault than is generally supposed. This is, no doubt, because lead sulphate is very difficult to reduce, so that bad contacts formed on discharging are not made good on charging. The writer has suggested the use of sodium sulphate to prevent this, and Mr. Starkey, and after him others, have found the method effectual.

ARC LAMPS.

There is little in connection with arc lamps that comes strictly under the heading of Electrical Measurement, but there are one or two points which may be discussed even at the risk of a digression.

An arc lamp cannot be considered by itself as an incandescent lamp can, for its action depends not only on its own mechanism but on the working of the dynamo, and most especially on the kind of carbon used. All that is demanded of the mechanism is that it shall keep the arc as steady as possible. With several lamps in series it is easy to make them burn steadily, but with lamps in parallel it is generally necessary to put resistance in series with each. An arc behaves very much as if it were a seat of a back electromotive force. There is no reason to suppose that there is any back electromotive force. As Mr. Harrison has pointed out to the writer, the phenomenon may be explained without any such assumption by supposing the cross section of the arc, that is of the heated air which forms the conducting passage, to vary as the current. This is a most natural explanation, as the arc certainly appears larger when the current is large, and one would never expect it to be otherwise. If the specific resistance of the heated air remains the same, and the cross section of the conducting part varies as the current, the arc would behave exactly as if it had a constant back electromotive force, and a given electromotive force, such as 50 volts, for instance, would be enough to maintain any current through the arc. In practice, an arc behaves much as if there were a back electromotive force of about 39 volts, and a small constant resistance of about an eighth or a tenth of an ohm. This may be due to the conductivity of the arc not varying exactly as the current. The difficulties in running arc lamps in parallel, or in working search lights without resistance, is due to the arc behaving as if it had a back electromotive force, so that a very small difference of electromotive force on the lamp causes a large difference of current. The difficulty is generally increased in search lights by the use of compound dynamos wound for constant electromotive force. The backward main machine would no doubt be much more suitable.

To talk of the candle-power of an arc lamp as a property inherent in it is absurd, as the candle-power depends on the carbons used and the current and electromotive force. It is unnecessary to go into the question of the photometry of arc lamps. Whether an arc lamp system is good or not is determined simply by its burning cheap carbons without flickering. Any lamp will burn expensive carbons, what is wanted is to burn the cheapest possible carbons with the best arcs.

PROJECTOR MIRRORS.

A search light consists of a large arc lamp, taking from 20 to 60 ampères, with a mirror arranged to throw as much of the light as possible in a parallel or slightly divergent beam. Search lights are sometimes called holophotes, though the term seems wrongly used, being more applicable to such things as Stevenson's holophote which was specially designed to utilise nearly the whole of the light of a lamp, while in the search light a large portion never reaches the mirror at all. The only form of simple mirror that will reflect the light in a parallel ray is the paraboloid. It would be too expensive to make such mirrors, so they are not used. A spherical mirror acts nearly as well, as the small part of the sphere is nearly coincident with the desired paraboloid. The spheroidal mirror, a spheroid being presumably an ellipsoid, concentrates the light from a luminous point in one focus on another point, known as the conjugate focus. The small part of the spheroid used would very nearly coincide with a spherical mirror. The Mangin mirror is an ingenious makeshift; it is a glass mirror with a silvered back, and both the back and front are parts of spheres, so that the manufacture is easy, but the surfaces are so arranged that the glass corrects the slight error which would arise if a simple spherical mirror were used, and makes the mirror send out the rays parallel, just as if it were paraboloidal.

To test a mirror it is supported at some distance from an arc lamp or other source of light. A small screen, say a disc of white paper two inches in diameter, is held on an adjustable stand, so that it can be moved about till the focus of the mirror is found. When the focus is found the image of the arc should be accurately shown on the disc. The mirror may not be held quite true. To make sure that it is right, care should be taken that the shadow of the disc falls in the centre of the mirror, which can easily be seen, as there is a central hole; and the image should fall in the centre of the disc. The arc lamp must then be in the principal axis of the mirror. If the mirror were truly ellipsoidal, and the lamp were in one focus, the image would be perfectly sharp. If the mirror is spherical, some aberration must be expected. If the arc is at a considerable distance this is a very good test. If the mirror were a paraboloid it would be necessary to use another as well. One mirror would then be arranged with an arc lamp as in a search light, and it would be adjusted to give a parallel beam, this beam would then be received by the second mirror, and a perfect image of the arc should be thrown on the little screen.

In testing mirrors by simply using the search light, it must be remembered that the beam which appears parallel to anyone at the lamp really diverges very considerably. A perfect paraboloidal mirror would show a bright spot only 20 inches diameter on a distant object, such as the wall of a house. The whole of the light would, for instance, show only a bright spot in the centre of an ordinary church clock. Mirrors are never so perfect as this, and it would be useless to make them so.

If the mirror were truly spheroidal, the light could be converged to a point at one particular distance off. This also would be useless. The advantage in testing the mirror with the little focus screen is that it is easy to secure adjustment.

It has been assumed that a "spheroidal" mirror is ellipsoidal, but the word might also mean "sphere-like." The terminology of these curves is really unsystematic; one would expect an ellipsoid to be a plane curve like an ellipse, not a surface; and if an ellipsoid is described by spinning an ellipse, a "spheroid" would be nonsense, and a cycloid would be a sphere.

THE TELEGRAPH IN THE CRIMEA.

THE telegraph is so young that there are many people living who can remember its institution, and yet so old that the story of its early struggles and its first uses is heard with the interest attaching to the historic. Not the least of its many important applications has been its employment in the field in war time, and we propose to recall some incidents connected with its first introduction to the needs of the army. Some of the earlier numbers of this year's *Military and Civil Service Telegraph Bulletin* contained a detailed narrative from the pen of Major C. F. C. Beresford, supplemented by correspondence, giving an account of the telegraphs used for war purposes during the campaign of 1854-55 in the Crimea and the Black Sea, and we shall base our sketch upon the statements advanced in that interesting periodical.

It was probably due to the initiative of General Wylde, a retired officer of the Royal Artillery, who was at the time deputy-chairman of the Electric Telegraph Company, that the idea was entertained of laying down a field telegraph in the Crimea. The Black Sea cable, connecting Varna with the Crimea, had already been laid, and General Wylde suggested to the Government that an addition to the submarine cable in the shape of an overland telegraph in the hands of the Royal Engineers would prove of great service. The Government was sufficiently impressed with the importance of rapid communication, to give the order for a number of sappers to be instructed by the Telegraph Company in laying and working telegraph lines. A very short time was devoted to the training of these sappers, and it turned out that it was almost so much time wasted, for only one of them was eventually employed in working the telegraph. This one man, however, a Corporal Fraser, taught other sappers, who, considering the difficulties of the situation and the scant opportunities for tuition, discharged their difficult duties in a commendable manner.

The stores and equipment were designed by Mr. Latimer Clark, who was at that time engineer-in-chief to the Electric Telegraph Company. The line was in the form of cable, and consisted of a No. 16 B.W.G. copper wire served with gutta percha. It was rolled on drums and packed, with the other stores, in two large waggons. The instruments were single needles fixed on tripod legs, with batteries (modifications of Daniell's) slung underneath. The equipment, with 24 miles of cable and eight stations, arrived at Balaclava on December 6th, 1854, but the line was not laid till the snow had cleared off the ground in the following February. On the 27th of that month a detachment of 25 sappers, under Lieut. Stopford, R.E., commenced the work by digging a trench 1 foot 6 inches deep, in which the cable was laid. The line extended from head-quarters to Kadekoi, and on March 7th communication between the two points was possible. Soon after, the line was prolonged to Balaclava, and other lines were laid from head-quarters to Kamiesh, the Left Engineer Park, the Light Division head-quarters, Waronzoff Road and the Monastery of St. George, making a total length of about 21 miles. Captain Ducane, R.E., was at first placed in charge of all the field telegraphs. Frequent interruptions and breakages took place, for not only was the cable not laid with the skill which experienced men would have shown, but it is said that the soldiers sometimes cut off lengths of it, drew out the wire, and used the gutta-percha for pipe stems.

As the demands upon the telegraph grew, it was found desirable to employ the services of men more experienced than were the Royal Engineers, and accordingly Mr. S. Alfred Varley, accompanied by an assistant, a lineman, and ten or twelve clerks from the Electric Telegraph Company arrived in the Crimea in August, 1855. Mr. Varley's commission appointed him to the charge of the field telegraphs at the seat of war, and he was to report himself to the officer in charge. His position was not very clearly defined, but he worked under the Royal Engineer officer in charge, the telegraphs being at that time under the command of Sir Harry Jones. The telegraphists at head-quarters were all sappers, Mr. Varley and his lineman being the only civilians at that station. There were seven outlying stations, namely, Kadekoi and Balaclava to the south, the Engineers' Park, the Light Division, and "the Caves" to the north, Kazateh, where the shipping lay, and St. George's Monastery, where the Black Sea cable landed.

Two of Mr. Varley's staff were placed at the Monastery, which was an important station, as all the London messages passed through it, and the rest were spread over the other stations. The military and civilians worked together at all the stations without the slightest hitch.

The number of messages forwarded from head-quarters averaged from fifteen to twenty per day, and the number received was about the same. A report at dusk of the state of the front was daily sent in to head-quarters, and also a report at daylight of what had been done during the night. All ships arriving at Balaclava, and the number of officers and men they contained, were reported to head-quarters, and "Time" was sent from Kazateh twice a day. Each circuit was connected to earth, the line being thus cut up into a number of short circuits. If two extreme stations wanted one another, the intermediate ones had to be successively called, and they joined the wire through. Serious delays arose from this arrangement, but upon the whole the work was fairly well discharged. The greatest speed obtained upon the circuit was under five words per minute. Mr. Varley, in a letter written at a little later period, says:—

> The wire was very frequently broken from being so near the surface: and when this was the case, the sappers who worked the telegraph went after the fault, and, having found it, they twisted the wires together, wrapped them with gutta-percha, and melted this with a lucifer. In consequence of the numerous bad joints from this mode of making them, the insulation was very defective. When we arrived I, of course, saw that they were made properly, the lineman doing it instead of the sappers. I also cut out all the bad joints I came across, but there were undoubtedly a great many, when I left the Crimea, still existing. The construction of the instruments was not good; you could not get at the inside without taking the instrument entirely to pieces and unsoldering the connections, which was nearly a day's work for a man, and the Crimea being dreadfully dusty, dust pervaded everything. The batteries had flannel instead of sand to prevent the acid spilling; this was a bad substitute, but no sand of a suitable character could be obtained. They were very inconstant in their action, and the sulphate batteries sent out were not supplied with sufficient sulphate of copper to charge the whole of them even once. I used them for the most important stations, and of course they were very steady in their action, and worked satisfactorily at these places. The telegraph was, however, actively engaged, and pretty well at work all day. The great drawback to its being much more useful was the original bad construction of the line, which caused frequent breakdowns and consequently a want of confidence in it, and the inefficiency of the staff who worked the instruments. Blunders were frequently made, and sometimes of a serious character.

Mr. Varley and his civilian staff were present in the Crimea during the most exciting times, but it was found that the hardships of the Crimea were too great for many of the civilians, although Mr. Varley thought they would have become acclimatised in time. Before the end of the year, 1855, they were sent to work the lines from Constantinople to Varna, under Major Biddulph. Mr. Varley himself was stationed at Therapia.

Whilst at Therapia Mr. Varley forwarded a report to Major Biddulph commenting upon the delays experienced in getting the attention of a distant station in consequence of the delicate adjustment of the instruments in use, and upon the growing importance of time in the transmission of messages, and recommending the employment of the double current keys of his brother, the late C. F. Varley, two of which were sent out by Government for use on the Black Sea line. He asked the permission of Major Biddulph to make a trial of these keys. Cromwell Varley's double current keys had already in England superseded those which were being used on the Black Sea cable. Mr. S. A. Varley offered to demonstrate, if an opportunity were afforded him, that much more rapid transmission was possible with his brother's keys than with those of Mr. Newall, then employed. In reply to his communication Major Biddulph said he did not deem it advisable to make a trial of the new keys, for he was perfectly satisfied with the work performed by the instruments he had been furnished with. He did not content himself, however, with this refusal, but took the opportunity to adminster a reprimand to the young superintendent in these terms :—

> I am sorry to find by your letter to me, as well as from your constant telegraphic correspondence, that you are but little acquainted with these instruments, or even with the nature of the interruptions that have taken place. It appears that you do not even know when an interruption is due to a breakdown of the line or to a derangement of the instrument.
>
> I am not come hastily to such a conclusion. You have been in charge of the Therapia station now upwards of three months. I have been now resident at the office for five weeks, and ever since I have taken the arrangement of your station into my own hands, I have completely succeeded in carrying on the communication without interruptions, such as were most frequent before.

This letter was dated February 5th, 1856. Eight months later he had either discovered that he had made a mistake or descended to the questionable action of giving a testimonial which he believed to be undeserved, for on October 8th Mr. Varley received the following letter from him :—

> Pera, *October 8th*, 1856.
>
> My Dear Sir,—It is with sincere regret that the necessity for reducing the staff of the Telegraph Department now that the Allied Armies have left the East, obliges me to inform you that your services will be no longer required as a superintendent in that Department.
>
> Before I allow you to quit the service, I beg to communicate to you my high satisfaction at the way in which for the last year you have carried out the responsible duties of the Therapia station, where not only there was a constant attention to office duties necessary, but also a surveillance of 20 miles of telegraph line requiring great professional ability, as being at the end of a submarine cable of 170 miles long; and also fatiguing supervision, as the land line runs over a very rough and wild country.
>
> I sincerely trust that you will meet with the success your merits deserve, and feel sure that the experience you have gained in having so active a charge will not have been thrown away.
>
> I remain, yours very truly,
> M. A. BIDDULPH,
> *Capt. Res. and Lieut.-Col., Director of Telegraph Department of the East.*
>
> Mr. Varley, *Superintendent, Telegraph Department.*

Mr. S. A. Varley, we are happy to say, is still among the partakers of earthly joys and sorrows, and it is due to his reputation that the strictures of Major Biddulph, once published, should be set in their proper light before their subject's co-workers of to-day who may be presumed to be but little acquainted with the details of incidents happening so long ago as the period of the Crimean war. We are glad, therefore, to be able to state a few facts which may or may not afford an explanation of the tone of Major Biddulph, in the first letter which we have quoted, but which will at any rate show that Mr. Varley had animosities of a more or less personal character to contend against.

Shortly after Mr. Varley left the Crimea the ss. *Elba*, brought the cable to the Bosphorus for connecting Varna and Constantinople, and also Mr. Newall with some of his instruments of Freischen's invention, with which the line was to be worked. Mr. Newall was displeased when he learnt that Mr. Varley was to have charge of the circuit, and protested that his instruments were altogether different from all others, that it was impossible for Mr. Varley to know anything about them, and that therefore it was absurd to appoint him to the charge of them. Mr. Varley made the natural reply that he had not seen the instruments and therefore knew nought of their details, but he would undertake to be acquainted with them in a very few hours after they had been placed in his hands. When the time arrived for the instruments to be connected up, he asked to be furnished with plans. Not only were these refused, but Mr. Newall's engineers were instructed not to let him see either the instruments or the manner in which they were joined up. Major Biddulph was informed of these facts, but took no steps to alter them, ignoring, in fact, the communication in which they were made known to him. Under these circumstances Mr. Varley kept away from the telegraph office until he received instructions to take charge. During the laying of the cable it was desired to keep up communication with Therapia through the part of the cable laid, in order to report progress to Lord Stratford, the English Ambassador. After a time this communication failed, and Major Biddulph despatched a messenger with a peremptory command to Mr. Varley to immediately put right the instruments which he had not been allowed to see, and which he had been told he could not possibly understand. He went to the office and saw the instruments for the first time. They were different from any he had before seen, the connections being very elaborate, and the switches, relays, &c., being of a very complicated character. The connections were all out of sight, and the task of finding out the fault seemed rather formidable. But Varley was on his mettle; he first tested the line and earth connections, and then the instruments, in which he found a want of continuity. He located the fault and removed it, and in less than twenty minutes after receiving Major Biddulph's command, he was speaking to the ship. Thus the young man who "could not possibly know anything about" the instruments, demonstrated his ability to comprehend them, and why the officer in charge of the telegraphs should have subsequently expressed so adverse an opinion with regard to the electrical capabilities of the superintendent under him, is amongst those things which seem likely to remain unknown. The suggestion of trade antagonism displayed by Mr. Newall is comprehensible, but not so the disapproval of Major Biddulph.

Mr. Varley has done so much good work since, both in connection with telegraphy and in the development of the dynamo machine that this unsatisfactory incident, and the censure seemingly so unnecessarily bestowed, will be estimated at their proper worth by those of our readers who are personally acquainted with him, but we have thought it right, as a part of the history of field telegraphy, to put on record the facts we have given above.

THE BONTA TELEPHONE.

THE great Bell telephone patents of 1876 and 1877 are, as is well known to our readers, based upon the theory of the "undulatory current." Substantially the claim is made that speech in all electric telephones is transmitted by a current that is not intermittent or pulsatory, but is continuously undulatory and varies in strength. The wave line representing such a current, as far as its speaking function is concerned, is an unbroken one. This, says the *Scientific American*, does not imply that there must be no cessation of current. A current that shifts from a maximum in one direction, as from right to left, through zero or total absence of current, to a maximum

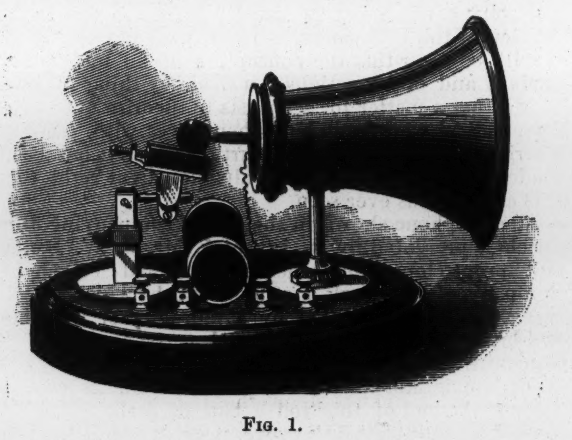


FIG. 1.

in the other direction, as from left to right, is considered a continuous undulatory current. This is necessarily the version of the owners of the Bell patents, as precisely such a current, the so-called "shuttle current," is used on their system, as adopted in practical use. The point is, that though there is an infinitely short period of rest, the transition to and from this point is gradual, and is represented by an unbroken portion of an undulating line.

Speech is assumed to be transmitted by a current of this nature. A "make and break" current, it is said by the Bell advocates, cannot of itself transmit speech. The logical deduction is, that in telephoning a perpetual control of the receiving diaphragm is preserved over it by the sending one. Both are assumed to move in unison, and only as the current crosses the zero line, changing in direction, is the distant diaphragm released from control, and then only for an infinitely short period.

The current as used in practice is assumed to be represented by an undulating line crossing as its median a straight line representing the trace of zero or no current. The current goes in one direction as the transmitting diaphragm recedes from, and in the other direction as it approaches the speaker. But it is probable that this reversal of the polarity of the current does not affect the receiving diaphragm, and that the latter is pulled by both impulses of the current, whether positive or negative, as regards the zero base line. The distinction between the undulatory and the pulsatory currents is very sharply drawn in the specification of the Bell patents. From what has been said, it will be clear that the conception of an undulatory current and of its actions is a shadowy thing at best. It is rather a matter for scientists to theorise over than for practical workers to busy themselves with. Yet in a series of very remarkable court decisions it has been made the basis of the most valuable patent right that this country has ever seen.

The telephone shown in the cuts accompanying this article is presented by its inventor, Mr. J. W. Bonta, and proprietors, the American National Telephone Company, of New York, as an apparatus by which speech is electrically transmitted by a pulsatory or a make-and-break current. The essential parts consist of a transmitting diaphragm, to whose back a pencil or rod of carbon is attached, which projects from its centre. Against the end of this rod a ball of carbon, free to move back and forth in a grove, rests in contact. The groove is formed in a block of carbon, and may, by special adjustment, be more or less inclined. The groove and projecting rod of carbon lie in the same vertical plane. One of the terminals of the circuit connects with the rod, the other with the grooved block. The whole combination forms the transmitting mechanism in connection necessarily with a battery. For use it is connected in circuit with a magneto receiving instrument. When spoken into, the voice is transmitted with great clearness and delicacy. It is exceedingly sensitive. The speaker may stand off several feet, with his back turned to it, and it will still transmit all his words. Its distinguishing peculiarity is that it breaks the circuit continually. When spoken into, the ball keeps jumping back and forth, rolling up and down the inclined plane. To regulate the extent of this motion, the angle of inclination of the plane can be raised, an adjustment, which is shown in the cut, being provided for this end.

As we have seen, the Bell patent is built on a theory, and, strange as it may appear, has been repeatedly sustained on such a basis by the courts. The inventor of this telephone, Mr. J. W. Bonta, has taken the bull by the horns, and has also secured a patent based on a theory. He claims that in the telephone we are describing, the intermittent current is used, and not the undulatory. Availing himself of the declarations in Bell's specifications that the undulatory current differs from the pulsatory, which declarations amount to a disclaimer, he declares that his instrument works by the pulsatory current. He asserts that it speaks by the succession of currents of uniform intensity and variable duration, and that their varying duration causes the reproduction of the sound.

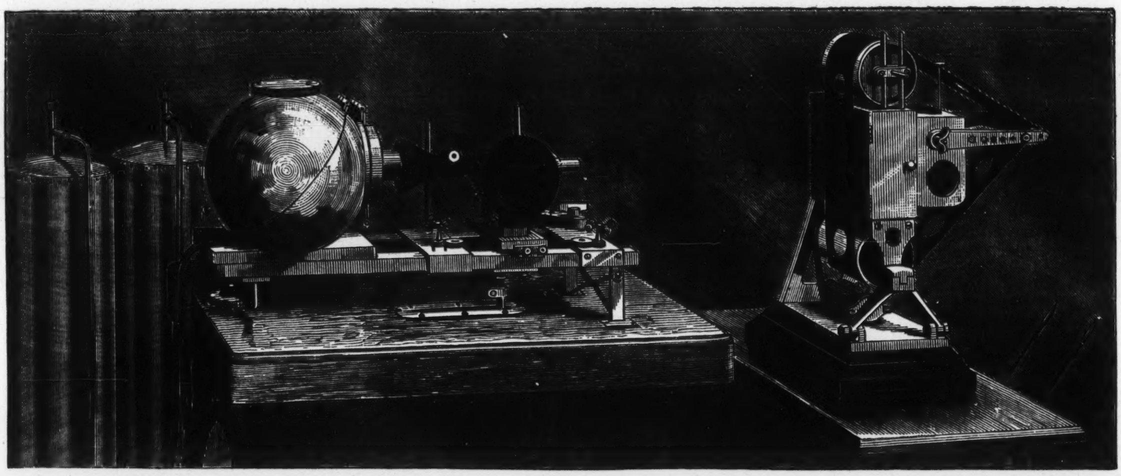


FIG. 2.

In order to illustrate at once and prove his points, Mr. Bonta arranged the apparatus shown in the larger cut (fig. 2). A magic lantern, with microscopic attachment, is set up, and as the object has the pencil and ball electrodes of the telephone in its field, these are projected on a screen as large as may be desired. If now some one speaks into the instrument, the image of the ball is seen to jump back and forth from the pencil electrode, as it opens or breaks the circuit continually. To investigate it still more accurately, a roll of sensitised paper is arranged to continuously rotate in the field of the projected image. In front of the paper, one side of an endless band passes, which band is kept in very rapid rotation. In the band are numerous apertures. This arrangement works like a series of shutters, bringing about a number of short exposures. The movements of the bands are effected by an electric motor, driven by a C. and C. battery.

The exposures are at very short intervals, as the band is rapidly rotated, and may run up to a large number per second. In a series of consecutive views, the electrodes are shown for the most part separated, proving that this phenomenon is not only an occasional one, but that it is repeated as long as the apparatus is at work. As a further test, a spring was made to press lightly against the ball. This kept the electrodes in permanent contact, but the telephone would not talk. This was taken as proving that a make-and-break action was essential to its operativeness. The point is also made that spring action interferes with the regularity of the makes and breaks, which regularity is essential. The apparatus for producing the separate exposures is shown in the right hand of the cut.

The proof is not, of course, a complete one. To make it such would involve an exceedingly difficult piece of photographic work, as from one hundred exposures per second upward would have to be effected. Enough has been shown to prove that a great deal of separation does take place, and that the electrodes are continually driven apart. The position of the Bonta patent in the light of the Bell claims is interesting, as it claims to utilise the disclaimed pulsatory current, thus dividing the field of telephony between itself and the Bell patent. It is not saying too much to assert that its theory is as good as that of the Bell specification.

RECKENZAUN'S SECONDARY BATTERY.

IN the REVIEW for April 22nd we briefly described a form of secondary battery devised and patented by Dr. Frankland, F.R.S., and it will not escape notice that the invention of Mr. Reckenzaun is to all intents and purposes identical with the foregoing, the latter patentee, however, having the good fortune to antedate Dr. Frankland by a very short period of time only. Before entering into the details of Mr. Reckenzaun's battery it may not be amiss to dilate, although somewhat briefly, upon storage cells generally.

Among the numerous systems of secondary batteries those of the Electrical Power Storage Company have been regarded as the most successful in the commercial sense, as well as in their constructive arrangements.

This company owns the patents of Faure, Sellon, Volckmar, Swan, and others, the first being acquired for the purpose of obtaining the use of his invention for the application of red lead or other oxides, which he pasted upon or into metallic lead supports. All the other patents held by the company control the use of perforated, indented, corrugated, or reticulated metal supports or plates, the hollow parts of which are filled with the paste devised by M. Faure.

The Electrical Power Storage Company and their host of imitators, amongst whom may be reckoned Julien, Epstein, Farbaky, and others, make or cast grids with square holes, somewhat conical internally, for the better retention of the oxide which is subsequently pasted into them. It is well-known that this paste expands, when converted into peroxide, through the electrolytic action in the cells when charging. This expansion takes place in each square, and consequently all over the plate, but, unfortunately, as the natural result of the varying mechanical resistance offered by the support, not *evenly*. Thus the paste in the centre of a square plate will have a considerable resistance to overcome by virtue of all the surrounding substance, whereas those parts nearer the edges encounter less opposition and expand more freely; hence the plate must become distorted, a state generally termed "buckling." Two neighbouring plates, if they do not buckle in the same direction will thus come into actual contact, and in the endeavour to avoid this the manufacturers place India-rubber plugs into the plates at short distances apart, so as to render the free unsupported surfaces as small as possible. These precautions, however, do not remove the *tendency* to unequal expansion; they merely offer a rude remedy which cannot remove the *cause.* Moreover, it occurs very frequently that the lead frames burst after prolonged use, this being another result of unequal expansion.

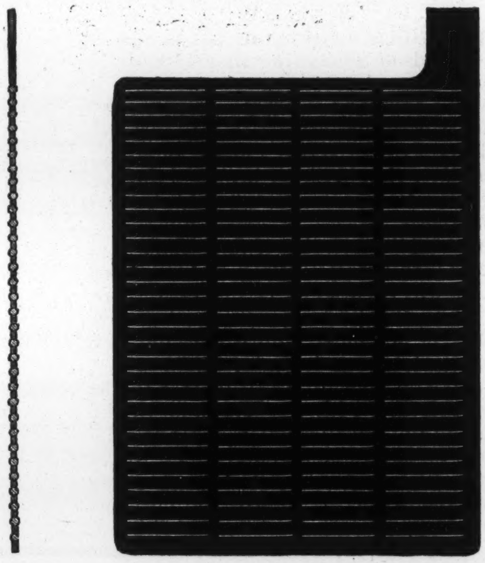
But a worse evil than this is found in the fact that the paste detaches itself from the conical support and drops out in halves or in smaller fractions.

This invariably occurs after a time even in the stationary cells, and such a fault renders perforated plates practically useless for purposes of locomotion. When shaken in a tramcar, for instance, the detachment of the paste is promoted to a large extent, so that the plates become unserviceable in the course of a few months, or even weeks.

The life or depreciation of secondary batteries of the systems indicated depends, first, upon the time necessary to cause the bursting of the grids through buckling, or the tendency to buckle, and, secondly, upon the period of retention of the paste in the holes. Under the best conditions, we do not think we shall be in error if we say that the life of such plates does not usually exceed two years if worked to their full capacity, and this means an expense which but few electric light installations can bear, and, so far as tramcars worked by accumulators of this description are concerned, there is little hope for success from a commercial point of view.

It may be mentioned that the India-rubber plugs form a very expensive item in the cost of secondary battery manufacture, both on account of the price of the material and the labour involved in fitting the plugs into the plates. Furthermore, the use of red lead as generally adopted renders the "forming" process at once troublesome, complicated, and costly.

We will now proceed to describe the improvements effected by Mr. Reckenzaun with the view of overcoming the disadvantages which we have enumerated, the sketch shown being taken from an actual plate in our possession. The inventor prepares small cylinders of spongy or finely divided lead or other suitable porous material, and places them at short distances from each other and in regular lines upon the lower half of an indented metal die. The two halves being fitted together, molten metal, preferably lead or a suitable alloy thereof, is poured in, thus forming a resultant conglomerate plate of great strength structurally, and from which the paste cannot by any chance become disengaged. The advantages claimed for this method of construction over other types of cells are as follows:—



1. Freedom from buckling, since any possible expansion can only take place in the direction of length.
2. No possibility of the active material becoming detached.
3. No India-rubber plugs or other costly separators; sticks or rings of any insulating substance suffice to keep the plates the requisite distance apart.
4. No double process of formation is required, the positive plates being exactly similiar and of the same material as the negatives. When the plates are connected up the cells are ready for immediate use.
5. No pasting in the ordinary sense is necessary; the porous cylinders are made by machinery and are consequently cheap.

6. The durability and certainty of action is vastly increased.

7. Whilst the cost of manufacture is considerably less, the depreciation is correspondingly smaller.

8. Large working capacity with small amount of material and little space—a 200 amp. hour cell measures $7\frac{1}{2}$ inches × 7 inches × 10 inches high.

9. Can be discharged at any rate without materially affecting the plates.

The following comparison showing the saving of material and labour, taking the E.P.S. cells as a basis, is given as an example :—The doing away with India-rubber plugs, and substituting sticks or rings, will give a saving of 6 per cent. in the prime cost. The plates of the E.P.S. Company have to be "formed" separately in forming boxes. The negatives are placed with "blind" positives and soldered up ; these negatives are then subjected to the "reducing" process for a period of about three to four days. The positives again are packed into similar forming boxes with "formed" or "partially formed" negatives and then soldered up ; the red lead paste is converted into peroxide and this process lasts two days. The connections of the positives and negatives have to be unsoldered again, the plates must be unpacked, and this with the double method of "forming" causes much expenditure of time, labour, and material. The value of this labour is estimated at 10 per cent. on the prime cost of the battery. We regret that owing to Mr. Reckenzaun's presence in America we cannot offer our readers any data compiled from actual tests of the cells, but from casual figures obtained with a battery which has been in operation for a period of something like 18 months, and from personal inspection at intervals, we have every reason to believe that a distinct and important advance in secondary battery construction is here shown.

It is most essential that a cheap, reliable, and durable accumulator should be forthcoming for the purposes of electric locomotion, and this we think Mr. Reckenzaun has produced.

It stands to reason that if the electrical propulsion of tramcars is to become more general, and who can doubt that this will eventually be the case, there must be a point where the conductor system, be it overhead or in conduits, is no longer admissible, and here it is that the accumulator *must* step in.

To make our meaning still plainer the loss on a conductor increases with the length of the line, whereas the loss in the transformation of electrical energy from dynamo to battery and from battery to motor remains a constant, no matter how long the tramway. It would be very interesting if some of our electrical engineers would enter into this question, and show for what distances properly proportioned conductor systems are less costly than the self-contained car with secondary batteries, and at what point the latter bears off the palm.

AMERICAN NATIONAL ELECTRIC LIGHT ASSOCIATION.

THE sixth meeting of this association, as we have already announced, was held at Boston at the beginning of August. Mr. J. F. Morrison, the president, opened the meeting with an address congratulating the members upon the success of their organisation, and reviewing the progress of the past six months. He concluded by introducing Mr. Hugh O'Brien, Mayor of Boston, who delivered an address of welcome. The meeting, after these preliminaries, proceeded to business, a report by the Legal Committee on patent legislation being first read and discussed. The report of the Wire Gauge Committee followed, consisting of elaborate tables. The association, it will be remembered, decided at its last meeting to abandon the B.W.G. and to adopt the metric system. Since then the committee has simply been putting the system into methodical shape. The report of the committee "On proper insulation of wires and proper installation and construction of plants," and that of the committee "On electrical distribution by alternating currents," which were next read, we hope to reproduce in a future issue. Mr. E. R. Weeks read a paper on "Electrical education," and a discussion as to the periodicity of the elections of officers brought a full day's work to a close. On the second day a paper by Lieut. J. B. Murdock, U.S.N., on "The electric light outfit for the new cruisers," was read and commented upon, and the remainder of the day was spent in an excursion to Deer Island, and, later, to the immense factory of the Thomson-Houston Company. In the evening a banquet was given to the visitors by the Boston Electric Club. Business was resumed on Thursday, August 11th, with a report on the revision of the constitution and bye-laws of the association, the discussion upon which took up the whole of the morning session. In the afternoon Mr. C. O. Mailloux read a paper on "The present status of the storage battery," and Mr. A. Reckenzaun followed with one on "Storage batteries for electric locomotion." These papers and the discussion thereupon, we shall place before our readers.

THE PRESENT STATUS OF THE STORAGE BATTERY.

By C. O. MAILLOUX.

IN one of his masterly newspaper interviews a well-known American electrician once said of the storage battery that it was chiefly remarkable for its power of stimulating the propensity for lying which is inherent in some natures. This sweeping assertion naturally makes me realise very fully the possible risk of compromising my reputation, which I run in undertaking to make a few observations relative to the storage battery.

Under the circumstances an apology might seem to you to be a suitable preface, but I trust that a simple explanation will suffice to dispel all doubts on your part as to my good faith in the premises. This explanation rests upon the fact that the storage battery, like the dynamo, the arc lamp, the incandescent lamp, and many another thing has grown and progressed. Only a year ago I would have hesitated, perhaps refused, to say anything before you in favour of the storage battery. My reason would not have been a lack of confidence, but rather a feeling that the era of the storage battery was not yet at hand. I felt that this youthful offspring of the great and powerful family of electrical applications promised to play as important an industrial *rôle* as any of its colleagues, but I also knew that it had already made one *début* some years ago and failed to draw, because it was too young. I would have been sorry to see its chances of success for ever spoiled by a second premature attempt. The child seems, however, to have now had sufficient time to mature and perfect its training, and after an interval of some five years it has reappeared upon the scene, this time with a fair and encouraging success. Within a few months there has been in America a great revival of interest in the storage battery, as you are aware. Many of us practical men, who were once disposed to be sceptical, begin to regain confidence. Certainly the applications which have been made of the storage battery in this brief period prove beyond dispute that this time the storage battery is coming to stay. In some cases it found a new and profitable field waiting for it, as for instance in railroad car lighting. In many other cases it opened an entirely new range of possibilities by its playing a secondary *rôle*. In a word, it has a wide sphere of usefulness to cover, through many devious paths, some of which it alone can tread over, and many of which it will compass with the help of other applications of electricity. It does not presume to fill all these parts at once. In the case of some of them it may prove wise to permit the process of evolution to go on for some time to come, before they are considered.

It is not necessary, however, for the storage battery to wait until it can accomplish *everything* before accomplishing *something*. There are many applications where it is now entirely competent to give satisfactory results ; and while doing what it is at present capable of, it can learn what it does not know. The dynamo was not at first what it is now, nor was the lamp, nor indeed the details of lighting systems. Electric lighting was limited at first to isolated installations. The range of adaptability, compared with what it now is, was limited greatly. It was necessary to confine the applications of the light to isolated cases of fitness, since the apparatus was too limited in every respect to admit of doing more. But while we were doing what lighting could be done with these facilities—and making money, too, even then—we were learning to do more. Invention, and the yet greater force evolution, were hard at work to give us better ideas and more practical devices. In time came the central station, such as it was—and I might emphasise the *such*. Many are here present, doubtless, who were operating these pioneer arc light stations, with long rows of dummy lamps, to be shifted in or out of circuit for the purpose of balancing the work in the circuit itself. Then came the current regulator, and following in its wake succession of devices and improvements, of methods, of systems. The evolution of the incandescent light is also of equal interest, and from the useless platinum wire lamp to the very useful alternating system of to-day, the steps are so numerous and strange that the mind finds itself in a regular museum in attempting to retrace them. I need not tell you that the evolution of the electric light is not complete—the very existence of our organisation proves that, since our object is to promote and further the process of development. Each year we have found electric lighting advancing a few steps. Ten years from to-day we may have made so many of these steps that our present systems may seem obsolete, yet these very systems in their time were good enough to earn dividends with. This is precisely the case of the storage battery. Its application can even now play a brilliant part in electric lighting, but it can be very useful even if intrusted with a more modest part. In a word, it has arrived at that age and condition of development which fit it to enter the active service of civilisation and begin the race for promotion. If I may judge by the very favourable attention which the storage battery has received from the public, and particularly from those who are dispensing electricity to the public, I think I can venture like our very genial friend and learned colleague, Dr. O. A. Moses, to prophecy that the storage battery is going to be the next great step of progress. It has already taken its place in line, and I believe it will speak for itself inside of a year.

With regard to the storage battery itself, it may be said that in following its development since the days of Planté, one meets with an already large and interesting collection of ideas and devices. It is outside the scope of the present paper to enter into the study of the steps by which the art has arrived at the present stage. The number of patents relating to storage batteries in this country and in Europe is already quite large, nevertheless the number of good storage batteries is exceedingly small. In this respect history repeats itself. The large and constantly increasing number of patents on dynamos, lamps, regulators, converters, and what not, when contrasted with the small number of those inventions which are really useful, suggests that a large proportion of inventors must have been engaged too deeply in taking out patents, and pay altogether too little attention to the work of reducing their inventions to practice. Passing by the history of the secondary battery and the theories of its action, which properly have no place in a paper like this, it might be of interest to dwell briefly on the objections urged against the storage battery. The two chief objections are, limited life or durability and low economy. I shall frankly admit at the start that in many cases these objections are sufficiently valid to throw the storage battery out of competition. The final commercial test of the storage battery, however, is the prospect of gain which it offers, under the circumstances of any given case. Viewed in this light the above objections to the storage battery lose some of their force. I can cite as an example the case of a Philadelphia hotel which it is proposed to light by electricity. A practical electric light man, who has been engaged in the business of establishing and operating central station plants ever since the beginning of electric lighting, went over the case very carefully, and came to the conclusion that the storage battery would be preferable. So well satisfied is he of the fitness of the storage battery that he submitted detailed propositions for furnishing light. The present cost of lighting the hotel by gas is $7,500 per annum. For the sum of $6,500 per annum, this practical man is willing to assume the responsibility of furnishing light for a term of years. Being a careful and shrewd business man he has made a wide allowance in his calculation. He does not count upon the two years guaranteed life of the battery plates, but assumes a necessity for their entire renewal in one year. He calculates, nevertheless, to make 15 per cent. on his investment, and I may say that he seldom makes mistakes in his ventures. In this case, the fact that light must be on "tap" for every moment of the 24 hours, becomes an important consideration, and the evident advantages of the storage battery outweigh the questions of durability and economy. Now, taking up the question of durability by itself, I may say that it is greatly dependent not only upon the kind of battery, but even upon the use to which it is put.

Then perhaps he may neglect to put in more than the quantity necessary for a normal capacity. The result is that the battery is not fully charged, and to furnish the usual capacity it must be discharged by drawing upon its residual charge. He soon finds his battery giving symptons of disease, and in a short time both the positive and negative plates will require doctoring, instead of one kind only.

It must be said, however, that improper care is not solely responsible for all the trouble that affect the life of the storage battery. Some difficulties like the scaling off of the active matter, the buckling and stretching of plates, are largely inherent in the battery. They are natural consequences of the manner or method of making the battery. So it may be said that here the storage battery has a personal equation depending on the make, the care, skill and knowledge of the maker. This amounts to saying that some kinds of storage battery are more troublesome to keep in order than others.

The life of the storage battery plate must not be regarded as doomed to remain compassed within the term of a couple or three years. The limit is gradually being extended, and it may be said that each suceeding batch of the product of a factory is slightly better than the preceding. The same may be said of the cost, which of course is an important consideration, in view of the necessity for repairs or perhaps for renewals at certain intervals. The cost of manufacture has been reduced 30 per cent. inside of one year, and it is even expected that it will be brought down to 50 per cent. before the year is up. The prices have not been reduced because the demand is great even as it is. This of itself shows that the storage battery has already a good field of usefulness where it can command to a great extent its own price.

The weight of the battery is another of the objections to be met particularly for street cars, &c. This objection is one which is of particular rather than of general application. It depends on the battery. We know however, practically, that with 27 lbs. of active matter, it is possible to provide a supply of energy for 6 lamp-hours, or over 10 watt hours per lb. of matter. This result will no doubt be improved upon greatly.

Last, but not least, among the objections used against the storage battery is that of reduced economy. My esteemed friend and colleague, Mr. Anthony Reckenzaun, whom you will have the honour of hearing after me, will give you very clear and precise information on the question of economy, more practically as regards the use of storage batteries for power. I will leave this portion of the subject to him because I know he is a most competent authority. I will permit myself also to commend his very intelligent work in Europe during the last five years, in the application of accumulators to electrical traction and propulsion.

The question of economy considered in relation to the storage battery does not present such difficulties as might at first be supposed. Considered as an apparatus for transforming energy for electric lighting by incandescence, the storage battery has an efficiency so much below that of the dynamo, or the transformer, that it cannot hope to enter into direct competition with these in many cases. Of the electrical energy produced by the charging dynamo, probably not more than from 65 to 70 per cent. finds its way into the lamps. With direct lighting, as we know, we may obtain as much as 90 per cent. But just here there is a question of great interest and importance which arises, namely: the proportion of energy appearing in the lamp as light. In an incandescent lamp probably not 5 per cent. of the energy expended is utilised as light. This 5 per cent. of rays represents the proportion of heat rays which are visible. The other rays are invisible. Now it is also well known that this very proportion of the useful light-giving heat increases with the absolute temperature of the filament. This means that the higher we raise the incandescence of the filament, the more light it gives for a given amount of electrical energy. But when the filament is brought to an excessive temperature its life is not so great. Just here I will note the fact stated by authorities that alternating currents have been found to increase the life of the filament as compared with continuous current. Now I can supplement this with the statement that the storage battery current gives yet much longer life to the lamp. It permits the raising of the filament to a higher degree of temperature, and consequently it leads to a gain in the energy required.

We have found in practice that we can obtain the same average life of 600 hours with a lamp of 2½ watts per candle-power, while direct currents would require lamps of 3½ to 4 watts per C.P. In our early work, realising the great disadvantage at which we are placed, we resorted to the use of lamps of higher economy, so called. The makers of these lamps refused absolutely to give any kind of life guarantee. They were themselves yet more surprised than we to learn of the remarkably long endurance of these lamps, even on board cars, where the filament is subjected to the wearing effect of mechanical vibration.

Of course I cannot pretend to say what is the cause of this increased life of lamps with the storage battery current. It is probably related in some manner to the fact that the current of a storage battery is continuous in the strict sense of the term, while the current of dynamos and transformers are wavy in character.

It would seem, therefore, that so far as electric lighting by incandescence is concerned, while the storage battery is opened to the objection of wasting at the spigot, it can claim some saving at the bung hole, which quite nearly equalises the difference between the results obtained by the direct and the storage method. Taking our 65 per cent. of energy, or in round numbers 485 watts, we can obtain 12 lights per electrical horse-power of 746 watts produced in the dynamo, using lamps of 51 watts, which is the most economical lamp yet heard of with a continuous current, we have the following results:—Out of 746 watts, taking 90 per cent. as available at the lamps, which is a liberal proportion, we have 671 watts or less than 12 lamps of 51 watts. If we consider the fact that in practice, lamps of 60 to 70 watts per 16 candle-power are the rule, the difference would be yet greater in favour of the storage battery. Taking another view of the question, we can calculate what is the lowest per cent. of efficiency permissible in the storage battery.

All applications involving the transportation of the cells, such as electrical car traction and railroad car lighting, necessarily shorten the life of the battery. In these cases the cells are subjected to hard usage, both mechanically from the shaking and jostling, and electrically from the severe rates of current discharge to which they are constantly subjected. Nevertheless, even here the life of the cells is quite remarkable. I might mention that a certain lot of 153 cells Julien type B were used for six months in street car work, where the current discharge was often raised to 80 or 90 ampères, whereas the normal rate was only 35 ampères. These cells were afterward put in use on cars of the Boston and Albany R.R., where they have been for some five additional months without being apparently much the worse for wear. It is probable that they will yet give good service for several months before they require attention. When stationary there is no doubt of their ability to last at least two years. At the end of this time the positive plates will probably need some attention. If the battery has been used properly, and not abused, the negative plates will yet be in as good a state as ever. In fact there is scarcely any limit to their endurance when properly used. One of the chief difficulties with regard to the care of the storage battery, is the tendency of the customer to overdraw on the reserve charge of the battery. The constitution of the battery is such that like many others it is most prone to disease when it is most "run down." Consequently it should never be depleted or allowed to become faint from exhaustion. Keep it well fed and it will thrive. Keep it hungry and it will soon die of inanition. The battery should always be left with a certain percentage of residual charge, somewhere around 20 per cent. It is like a water tank which requires a little water in it all the time to keep it water-tight and in good condition. This reserve is not necessarily wasted. It only means that the battery should be worked at a lower capacity than it has in reality. The customer, however, is liable to overlook this important point, and when he finds that there is more electricity in the tank than he thought there was he tries to save energy by taking more out of it.

Taking eleven lamps as the result of the direct application from the dynamo, we find that the storage battery must, at 40 watts per lamp, supply 440 watt hours out of each 746 watt hours given to it, or somewhat less than 59 per cent.

I need not dwell at length upon the uses of the storage battery and the services which it can render in connection with electric light plants, for these are quite generally understood, and new ones suggest themselves all the time. The present rate of demand shows that the uses are at least equal to the rate of supply and sometimes in excess. One application of special interest in this connection, however, is that in connection with incandescent lighting, both from isolated and central station plants, the incandescent light is growing in favour so rapidly that where it is already in use for a certain number of hours during the evening, there is an objection to the use of gas at other times. In small installations it would evidently not pay to run constantly for a few lights. The storage battery would here be very useful, if not indispensable, and a number of local companies who could sell electricity for power in limited amount are also turning to the storage battery, since they are compelled to run during the day to supply electricity for a few lamps and motors, they find it would be as well to run to full capacity, using the balance of power to charge storage batteries from which the energy can be drawn later in the evening, to supply incandescent lamps.

In conclusion, I hope I have succeeded in making a fair presentation of the storage battery case, so far as it concerns the uses and purposes of electric light men. As I have intimated, the storage battery is as far from being perfect as were the first dynamos with which some of the enterprising men of this very body first paved the way to the great industry that now interests so many minds and enlists so much capital. But it is so far perfect, however, that it is ready to help enlarge this great industry to push further ahead in its wonderful development.

THE MAGNETIC FIELD.

THE papers of Mr. Carl Hering on the "Explorations of the Magnetic Field surrounding Dynamos" reveal some interesting facts concerning the machines dealt with. It is true the tests were made three years ago, and with machines most of which, we presume, have become obsolete, but they are still valuable as showing how machine frames ought or ought not to be constructed with regard to magnetic distribution. The object in all dynamo construction is to obtain a strong magnetic field in the gap, between the poles of the magnet and the armature core, in which the conductor moves, and for the purpose of achieving this end some have attempted to surround the armature itself by magnetising coils, which thus act directly to produce the strongest field where desired. It is not unlikely that by these means a stronger field may be produced in the gap for a given exciting power, but the disadvantages attending this construction—such as the difficulty of removing the armature and general inaccessibility of parts—are so great as to militate against its general adoption. The additional ampère turns required for the production of the field is a small matter compared with the great advantages possessed by machines designed with an eye to the prompt execution of repairs. We are, therefore, inclined, these things considered, to wind the magnetising coils not over the armature directly but on masses of iron brought into close proximity with it, content to sacrifice, in leakage across the poles, a certain portion of the field we create, but keeping the space between polar surfaces and armature core as small as possible that the sacrifice may be a minimum.

The whole of the space, through which the lines of force curve, may be considered as in the magnetic circuit, inasmuch as it serves for their conduction whether filled up with iron, copper, or air. Lines of force always form closed curves, and from Mr. Hering's maps some appear to close in curves embracing a very small area, while others stretch away out into space. It really matters very little where the lines of force stray after they are made to go through the armature. They may go through iron or through air, the only difference being that a greater excitement is required to produce the field where it is wanted in the latter case than in the former. A curious distribution is shown by the "Jumbo" Edison machine, where the iron part of the magnetic circuit is not of uniform section throughout. On the top side we have two sets of magnet cores, and two massive pole pieces, one above and one below, to guide the lines of force through the armature. But on the bottom side we have only one set of magnets and a thin yoke piece to complete the circuit; a great number of the lines of force going through the armature, stray therefore in the surrounding air to return to the top magnet cores. The bottom magnets and yoke are practically saturated, and on account of the high magnetic resistance resulting therefrom, a large amount of exciting power is needed to produce the requisite field in the conductor gap. In modern dynamos, with one or two exceptions, this defective construction has been avoided, the section of the yokes being always greater than the cross section of the magnet cores on which the coils are wound. The only way to diminish leakage, and at the same time to create a field with minimum exciting power, is to put plenty of iron in the magnets with a corresponding quantity in the armature core, taking care that the lines of force are not wire-drawn in any part of the circuit.

The map of distribution in the Weston machine seems to show that there is too little iron in the armature and yokes if Mr. Hering's lines can be taken as representing by their closeness the density of the field. The maps of the Van Depoele and Thomson-Houston machines are also very instructive, the former showing how a machine ought not to be constructed, and the latter, "as usual," eclipsing everything in the extraordinary character of its field, and, according to our lights, the worst of the lot.

But these explorations show that much has yet to be learned respecting the magnetic fields. We are in England chiefly indebted to Dr. Hopkinson for investigations in this direction and the results he has given us concerning leakage in the two machines with which his name is associated, are very valuable. In exploring the field of an Edison-Hopkinson machine it was found that 24·4 per cent. of the lines of force passing through the magnet cores strayed outside the armature, the zinc base and iron bed-plate on which the magnets rest accounting for 10·3 per cent. In the "Manchester" machine, where the density of force lines in the armature core is much greater, and which has a ring instead of a drum, the total leakage reached as much as 30 per cent. of the lines passing through the magnet cores, showing that a small area of armature core means a greater leakage. Judging from the diagrams we should imagine that the leakage of a Thomson-Houston machine far exceeds this amount, and we trust Mr. Hering at the first opportunity will supplement what he has already done by taking quantitative observations of modern machines. It is impossible to base judgment fairly on note-book sketches, and we must confess to a weakness for seeing everything in plain figures resolved into percentages.

Fire Preventive Insulators. — M. Wybauw, of Brussels, has been experimenting upon various insulators from the point of view of precaution against fire in the event of over-heating of electric wires. He finds that lead tubes and caoutchouc, or silicated cotton rapidly give way, and the only resistant non-conductor, thus far, is amianth or asbestos.

REVIEW.

Electricity for Public Schools and Colleges. By W. LARDEN, M.A. London: Longmans, Green & Co.

Although the author (one of the Masters at Cheltenham College we believe) of this work professes that he has written it with a view to rendering it suitable for use in public schools, we do not think that he has carried out his profession in a particularly happy manner. The strictly elementary matter is, in our opinion, too much worked up with that of a distinctly advanced character. Thus at the commencement of the book in the chapter on the "General phenomena of magnetism," we have a page or two devoted to Prof. Hughes's theory. This is all right so far as it goes, but it is out of place in a book which practically professes to be purely elementary. The writer no doubt, like many others, wished to become an author, and moreover (most laudably) wished to be as original as possible, in this he has to a great extent succeeded, but what he has produced is not what can fairly be said to be generally suitable for school classes. The work is certainly an advance on what has hitherto been written, as the writer has practically taken the matter which is found in well known standard works on electricity, and has modernised every paragraph as it were by the addition of modern knowledge and theories, in doing this he has, we think, to a great extent pared down much ancient writing which was very useful, and which though ancient, is by no means obsolete.

As an advanced work, however, Mr. Larden's book is well worthy of recommendation, but it cannot be considered to take the place of such works as those of Noad, Ferguson, or Thompson, which deal with electricity in a strictly elementary sense.

A great point in the work is a number of useful examples with the answers to the same, which are given at the end of the book.

NOTES.

Electric Lighting in German Provincial Towns.—The public supply of electricity from central stations is not limited to Berlin only, says a correspondent of *Industries*, but is beginning to obtain a footing in various provincial towns throughout Germany. I have recently visited several places where stations have been erected, the more important amongst them being the following:—In Hanover there are two small stations already in activity, one for the supply of private customers and the other for the lighting of the Court Theatre. In this case alternating currents and transformers are used, the transmission being by means of an overhead iron wire 100 mils. in diameter, at a potential of 1,200 volts. The total commercial efficiency of the system is 58 per cent. A larger central station with underground cables for the supply of the inner portions of the town is in contemplation. In Magdeburg there is a small central station for lighting a block of houses, including hotels and shops, in the neighbourhood of the railway station, and in addition to this a separate installation for the theatre is now being fitted up. There will be two gas engines of 35 H.P. each placed in an annexe, and the building will be lighted from the dynamos direct. The works of Gruson and Schäffer & Budenberg in Buckau have also special electric light installations. In Brunswick a private person has erected a central station for 1,000 lamps, all the lights being in a block of houses containing business premises. In Dessau, which is the head-quarters of the Continental Gas Company, there is a very interesting installation which has been at work since last year, lighting principally the Court Theatre and the Castle with about 2,000 lamps. Power is furnished by four Otto gas engines, two of them 60 H.P. and one 30 H.P., working together on a countershaft, from which two 600-light and one 450-light dynamos are driven. The fourth gas engine is an 8 H.P. working a 100-light dynamo, which is used for charging a battery of Khotinsky accumulators, having a total capacity of 600 lamp-hours. The cost of the whole installation was about £15,000.

Seaside Electric Lighting.—The experiment of lighting the principal streets and the sea front at Weston-super-Mare for a period of one month with the electric light has commenced. The offer to make the experiment was made some months ago by Mr. Massingham, of Taunton, the originator and managing director of the Electric Lighting Company in that town, and, thanks to the enterprise of several of the tradesmen of Weston-super-Mare, the local electrician, Mr. W. T. Lalonde, was enabled to accept the offer. The experiment was on a sufficient scale, both in respect to the number and duration of the lights, as to enable persons in business and the townspeople generally to judge of its desirability as an illuminant in place of gas. The plant at Weston-super-Mare is the same as that used at Bath during the Jubilee, and consists of 30 arc lamps of 1,200 candle-power each, and these are maintained by a 30-light Thomson-Houston dynamo fixed in a small shed in a yard at the back of High Street. The total length of wire forming the circuit is about 4½ miles. The streets of the town were very crowded on the opening night, the lights never for one moment failed, and everybody seemed highly pleased with the efforts that had been made, while visitors were loud in their encomiums on the enterprise and public spirit manifested by the towsfolk. The time chosen for the experiment could not have been more opportune, for Weston-super-Mare is now full of visitors.

The Electric Light at the Brussels Exhibition.—At the Brussels Exhibition it is proposed to erect two 5,000 to 6,000 C.P. arc lamps at the main entrance on masts 60 feet high. Each arc lamp will receive current from its own small dynamo driven by a turbine, the generating plant being placed inside the pedestal of the masts. Water power will be supplied from the town mains.

The Telephone in Berlin.—The use of the telephone in Berlin is rapidly extending. At the beginning of July the number of subscribers was 6,262, and there were seven exchanges in the town and 21 in the neighbourhood. The postal authorities have some difficulty in keeping pace with the public requirements as regards the telephone service. At the present moment there are 1,000 applications lodged at the office, and new applications are coming in at the rate of 150 per month. The total number of separate circuits is about 10,000, of which 8,000 are above ground. The placing of wires underground is being opposed by the Town Council, who object to the frequent disturbance of the pavement, and are endeavouring to levy from the Post Office a tax for the use of the streets in the same way as they levy a tax from electric lighting companies who use the streets. Generally the town authorities raise no objection to overhead wires, and are even disposed to consider them as an element of safety. It has been observed that during recent thunderstorms those portions of the town which are most thickly covered with telephone wires enjoyed complete immunity from strokes of lightning, whereas damage was done in other districts. The explanation of this fact is that a large number of the posts supporting telephone and telegraph wires have purposely been connected with earth, and these posts form, together with the network of wires, a fairly efficient protective system.

Cape Telegraphs.—The staff of the telegraph department resident in Cape Town entertained their former chief, Mr. Sivewright, at dinner at the St. George's Hotel on his arrival in the colony, and advantage was taken of the occasion to present him with a massive silver cup, subscribed for by the officers of the department in all parts of the country.

Chinese Telegraphs.—The Government of Formosa, at the end of last year, decided to connect this island with the mainland by means of a submarine cable, and asked for tenders for the carrying out of the work. Messrs. Jardine Matheson & Co., were the successful tenderers, and placed the orders for the manufacture of the cable and the fitting of the cable steamer with the Silvertown Company. The *Fee Cheu* was built at Messrs. Doxford's yard, in Sunderland, and as well as being fitted with cable tanks and cable gear, she carries four guns of light calibre, and on account of her speed will be used, when not employed as a cable vessel, as a despatch boat. The cable will be laid under the superintendence of Mr. Joseph Rippon, assisted by Mr. Daley, both of the Silvertown Company's staff, and by Captain Lugar, who formerly commanded the cable steamer *Mackay Bennett*, and served for a considerable time in the repairing steamers of the West India and Panama Telegraph Company.

Telegraphy and Lightships.—Mr. T. Bradshaw, writing from Ramsgate to the *Engineer*, says:—"With a view of saving life here during the next few months, when wrecks occur at times three in an hour, permit me to call for tenders to erect and maintain a telegraphic communication between the three lightships and the coastguard station here. I should require the wire buoyed near each ship, with a separate wire from such buoys to the ships; and a prize will be paid for the best design submitted me. The line really would be laid in the same track as the submarine cable now lies, in two divisions, and with two buoys, to the nearest lightship to repair same easily."

New Cables.—We hear that, in conjunction with the Société Génerale des Téléphones, Messrs. W. T. Henley and Co. have contracted with a French syndicate for the laying of cables in the West Indies, between Venezuela, Curaçao, San Domingo, and probably Cuba. The whole, or at least a large portion of the core will be manufactured in France, and part of the cable will be sheathed in that country. The greater portion of the sheathing will be carried out by Messrs. Henley & Co., who are extending their works for this purpose. The laying of the cable will be undertaken by Messrs. Henley and Co., who are at present on the look out for the cable-laying staff and for a ship, which they will fit with the necessary cable gear, &c. It is contemplated to extend the San Domingo line to the United States at a later date. The whole work will comprise some 2,000 nautical miles of cable.

Atlantic Cables.—We understand that the ss. *Faraday* successfully repaired the Jay-Gould Atlantic towards the end of last week, and is now on her homeward passage.

The ss. *Mackay-Bennett* is still absent, and we have no precise information as to her whereabouts or the work she is engaged upon. It seems, however, that she has been, or is employed on some deep-water repair.

Electric Lighting in Switzerland.—The Winterthur correspondent of *Industries* states that the electric light is making great strides in Switzerland. Hotel keepers and others interested in the prosperity of watering places have discovered that the electric light is almost a necessity if they would attract visitors, and as they are not wanting in enterprise, electrical engineers are kept well employed. The electric light was installed at the beginning of June in the large hotels in Engelberg, in various places in the Berner-Oberland on the lake of Lucerne, and also at Schaffhausen, where the fall of the Rhine is every night brilliantly illuminated with arc lights. In this case, the power is supplied from a turbine driven by the stream. In most places in Switzerland water-power is obtainable at a small initial expenditure, and this circumstance naturally facilitates the introduction of the electric light very considerably.

The Proposed Electric Railway at Littlehampton.—Not long since the Local Board of Littlehampton, desirous of rendering the town more attractive, passed a resolution sanctioning the establishment of an electric railway. However, the Local Government Board inquiry proved hostile to electricity, it being suggested that a horse tramway would be more suitable. Plans to carry a scheme of that kind into effect have been laid before the board, but have been negatived by a large majority as "an unmitigated nuisance without a single redeeming feature." There is still a strong feeling in Littlehampton in favour of an electric railway, which, it is believed, would have the happy result of bringing a large influx of visitors into the place.

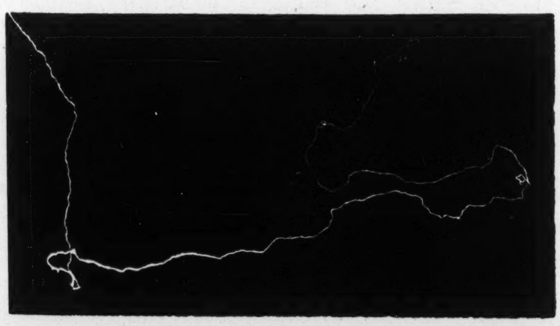
University College, Bristol.—This college has been recently enabled to make a notable advance in the matter of engineering education owing to the generosity of local firms. At a meeting held in the early part of the present year, under the presidency of Mr. Albert Fry, the desirability of instituting engineering scholarships was considered. The practical outcome of this meeting was that most of the firms of the neighbourhood agreed to institute bursaries or scholarships at their works. The holders of these are to be nominated by the college authorities. Some will be awarded on the results of the annual examinations, while others will be reserved for deserving students who may be unable to pay the usual premiums required on entrance into works. The educational scheme adopted at Bristol does not include any attempt to impart practical workshop instruction within the college walls; but the students spend six months (April to October) in each year acquiring practical experience in the works and drawing offices of the engineers of the West of England. This system is found to answer so well, that Messrs. Stothert and Pitt, of Bath, and the Bristol Waggon Works Company, propose to make it obligatory on all their pupils to attend the college courses in the winter months for the first three years of their pupilage. Several firms have also signified their willingness to take college students for short periods, so that civil engineering and electrical engineering pupils may spend one or two terms of six months in works; while at the same time mechanical engineers may have experience in two or three different establisments during their college career. In return for these concessions the council of the college has decided to permit deserving apprentices or artisans, nominated by the local engineers, to attend the college courses at reduced rates. It is expected that about nine first class scholarships, and a larger number of second class ones, will be available during the coming session. The following are the names of the firms which have already placed at the disposal of the college authorities one or more scholarship places in their works on exceptionally favourable terms:—Messrs. Stothert and Pitt, Bath; The Bristol Waggon Works Company, Bristol; Messrs. Cox & Co., Falmouth; Messrs. Newall & Co., Bristol; Messrs. Willoughby Brothers, Plymouth; Messrs. Bush and De Soyres, Bristol; Thos. Peckett, Atlas Engine Works, Bristol; Messrs. John Watts & Co., Bristol; Messrs. Spencer & Co., Melksham, Wilts.

Institution of Civil Engineers.—Amongst the subjects upon which the Institution invites papers are:—(18), The production of aluminium and its alloys, with their properties and uses; (43), Electro-motors; their theory, construction, efficiency, and power; (44), The construction and maintenance of secondary batteries; (45), The distribution of electricity for the lighting of towns; (46), The application of electricity to the working of street tramways; (47), The application of electricity to smelting and metallurgical operations; (48), Means of insuring the safety of blasts in explosive atmospheres.

Civil and Mechanical Engineers' Society.—The offices of this society have been removed to 6, Queen Anne's Gate, Westminster, S.W., where future meetings will be held.

Central Station Lighting in Berlin.—The work in connection with the extension of the supply from the central electric light station known as the Städtische Elektricitätswerke in Berlin is rapidly approaching completion. The Royal Theatre has just been fitted with 1,500 glow lamps, which are supplied from the mains of that station, and the Royal Opera House is now receiving an installation of glow lamps, so as to be ready for the coming season. The total area at present supplied from the station is approximately a square of 1,600 feet sides, but further extensions are contemplated. The distributing plant has been put down in a most substantial manner. Briefly described, it consists of a network of mains, various points of which are joined to the station by feeders. These junctions are placed in special cast iron feeding boxes, and in addition to these there is a large number of distributing boxes where the service wires to the different houses are joined to the mains. The sectional area of the main conductors varies between ·24 and 1.4 sq. inch. The cables are all lead covered, with an outside serving of iron tape for greater protection; and in places where special precautions are necessary, such as street crossings, or in the neighbourhood of gas and water pipes, the cables are drawn through iron tubes. Where the streets are straight and of sufficient width the different cables have been laid side by side; but where sufficient space could not be found they are arranged above each other, with wood distance pieces between them. This somewhat elaborate system of underground street mains, says *Industries*, although rather costly, has the advantage of equalising the potential throughout the district, and of permitting easy access for purposes of repair or the connection of new subscribers. In order to distinguish the cables at any place each has been wrapped round at every 7 feet run with a short length of lead tape bearing a distinctive stamped mark.

A Flash of Lightning.—The illustration given below is an exact copy of a flash of lightning photographed by Mr. Joseph Gray at Brixton during the recent thunderstorm. The flash presents a most striking and eccentric appearance, gradually dying away at the right hand side, and as we believe in the distance, until it becomes too faint to affect the sensitized plate. This photograph of lightning is the most interesting we ever remember to have seen.



Personal.—Mr. J. A. Betts, A.M.Inst.C.E., and M.S.T.E. and E., who has been engaged for many years past in perfecting the coast defence of China, and who had command of the torpedo defence of Canton during the late Franco-Chinese war, has returned to England. Mr. Betts has had some very rough experiences with the "Black Flag" troops during the fighting with the French and Annamese legions on the Tonquin frontier.

Antwerp Exhibition.—The reports of the committees appointed to examine the various exhibits have lately been published. We gather from the report of the sub-committee entrusted with the testing of instruments for electrical measurements, that anything but favourable results have attended their experiments, the percentage of errors in this class of apparatus being found to attain considerable proportions.

Self-Winding and Synchronising Clock Company.—There exists considerable uneasiness amongst the shareholders in this company in consequence of the action, or inaction, of the directors, and this has been in no wise lessened by the issue by Mr. J. A. Lund of the following circular, addressed to them: "Gentlemen,—It will be in your recollection that it was arranged with myself that I should accept the managership of your company for one year, and that the matter should then receive further consideration. I am well aware that a considerable number of the shareholders subscribed on the faith of my connection with the company. I feel, therefore, that it is due to those who thus gave me their confidence, to state that after reiterated protests on my part to the course pursued by the directors, and without any attempt being made to reconsider or modify the terms of the arrangement, they informed me a few days prior to the expiry of the year, *i.e.*, August 1st, that on the ground of expense my further services would not be required. Immediate steps should be taken to call a special meeting, when I shall be prepared to lay the whole case before them. I willingly leave my own interests, which have very seriously suffered, in the hands of the shareholders, but I am anxious that steps should be promptly taken to save the company from what I consider to be a very critical position."

The Eclipse Battery.—The editor of the *Telegraphist* relates in yesterday's issue of that journal his adventures in search of the wonderful apparatus which so fascinated the impressionable reporter of the *D.T.* After waiting a long time at the White House in Telegraph Street, Mr. Lynd, for we presume t'was he, had to go empty away, feeling that scientific opinion was shunned by the gentlemen who so modestly ask the public for that £60,000.

University College, Dundee.—The Calendar for the fifth session of this college is just published, in which is included the report of the Principal, Dr. Peterson, for the last session. He states that the total number of day students was 144, and of evening students 199. Of the day students, more than twenty have already matriculated at St. Andrew's University with the view of proceeding, at the end of their course at Dundee, to the degree of Bachelor of Science. Particulars of the examinations for this degree are also given in the calendar. The Principal considers it a matter for sincere congratulation that at a time when the need for technical education is being proclaimed throughout the country, and is being pressed by responsible statesmen on the attention of the Government itself, arrangements should have been happily completed by which Dundee will secure the advantages of a well-graded system of instruction in science and technology. With the accommodation shortly to be placed at their disposal, the staff of the college and the institute expect to be in a position to meet all reasonable demands. Professor Ewing reports that the engineering classes have held their position in point of numbers, and announces his intention of commencing a laboratory class in general engineering, which will form a preparation for the more extensive laboratory work that will become practicable when the Technical Institute is opened. He also intends to offer a popular course of ten lectures on electric lighting, using the laboratory for experimental demonstrations of the subjects treated in the lectures. The following remarks in the report of the Professor of Biology are amusingly pathetic:—"Our lack of space, both for the storage and the display of specimens, is very serious. My own private room was long ago given up to be a store-room; we have stored specimens in the garret and cellars of Prof. Steggall's department. Dr. Carnelley also lends us a room in the basement of his laboratory; the hall behind the church is full to repletion, and within a very few weeks the corridor of the college will be nearly filled. Even Professor Gilray's class room had to be made to do duty as a temporary botanical laboratory."

Advertising.—A second edition of a curious little book, called the "Advertiser's Guide to Publicity," has been issued by Moody's Printing Company, Birmingham. The publishers having favoured us with a copy we have pleasure in quoting the following as a sample of the good advice offered by the writer to that large class of business men who seek to make a proper use of this most important means of achieving success: "Advertising has undoubtedly become the most important feature of this commercial age, for the obvious reason that, in the extreme competition everywhere existing, no one can afford to wait whilst the public find out by accident the intention and ability to serve them well, or the benefits to be derived from new discoveries and inventions; therefore, the first step to success in any department of trade is to become known by attracting public attention in some way. . . . . Trade and class journals are becoming the best mediums for general purposes; not only because they are better got up and allow better display both for the type-setter and the artist, but because in them there is the advantage of addressing more directly and particularly those whose attention it is most desirable to attract."

South African Tariffs.—It may not be generally known to our readers that on July 1st, 1887, there came into force a convention entered into by Governments of Cape of Good Hope, Natal, Orange Free State, and South African Republic, for the establishment of an uniform telegraph tariff between these States. The rates agreed to are:—For ordinary telegrams, one shilling for the first ten words and sixpence for every additional five words or fraction of five words. For cypher telegrams an increase of 50 per cent. on the price of ordinary messages. For press news a fourth of the rate applicable to an ordinary message of same length, but with a minimum charge of one shilling. These rates are also to be applied to cablegrams between the said States.

Modern Chemical Ideas.—Sir Henry Roscoe states that the germs of the theory of valency, one of the most fruitful of modern chemical ideas, were enunciated by Frankland in 1852, but the definite explanation of the linking of atoms, of the tetrad nature of the carbon atoms, their power of combination, and of the difference in structure between the fatty and aromatic series of compounds, was first pointed out by Kekulé in 1857; though we must not forget that this great principle was foreshadowed so long ago as 1833 from a physical point of view by Faraday in his well-known laws of electrolysis, and that it is to Helmholtz in his celebrated Faraday lecture that we owe the complete elucidation of the subject; for, whilst Faraday has shown that the number of the atoms electrolytically deposited is in the inverse ratio of their valencies, Helmholtz has explained this by the fact that the quantity of electricity with which each atom is associated is directly proportional to its valency.

Electric Lighting Golore.—The *Morning Post* to whose utterances we have drawn attention elsewhere says:—"The value of Mr. d'Humy's invention has been recognised on the Continent. He has secured a contact for Madrid, in which city he has to supply, within four years, about 200,000 lights of various candle-power. At Paris, also, he has obtained a contract for putting down 50,000 lights, whilst at Havre he has to supply several thousand lamps. It is the intention of Mr. d'Humy to establish in London four central stations for supplying the electric light—at Gray's Inn Road, South Kensington, Addison Road, and Hammersmith respectively; but the whole of them will not aggregate more than 3,000 lamps. This is a very small beginning for a metropolis like London; but the obstacles placed in the way of those who wish to introduce the electric light here are enough to appal the stoutest heart."

Thermal and Electrical Chemistry.—We extract the following from the B.A. Presidential Address:—"But recent investigation in another direction bids fair even to eclipse the results which have been obtained by the examination of thermal phenomena. And this lies in the region of electrical chemistry. Faraday's work relating to conductivity of chemical substances has been already referred to, and this has been since substantiated and extended to pure substances by Kohlrausch. It has been shown, for example, that the resistance of absolutely pure water is almost an infinite quantity. But a small quantity of an acid, such as acetic or butyric acid, greatly increases the conductivity; but more than this, it is possible by determination of the conductivity of a mixture of water with these two acids to arrive at a conclusion as to the partition of the molecules of the water between the acids. Such a partition, however, implies a change of position, and therefore we are furnished with a means of recognising the motion of the molecules in a liquid, and of determining its amount. Thus it has been found that the hindrance to molecular motion is more affected by the chemical character of the liquid than by physical characters such as viscosity. We have seen that chemical change is always accompanied by molecular motion, and further evidence of the truth of this is gained from the extraordinary chemical inactivity of pure unmixed substances. Thus pure anhydrous hydrochloric acid does not act upon lime, whereas the addition of even a trace of moisture sets up a most active chemical change, and hundreds of other examples of a similar kind might be stated. Bearing in mind that these pure anhydrous compounds do not conduct, we are led to the conclusion that an intimate relation exists between chemical activity and conductivity. And we need not stop here; for a method is indicated indeed by which it will be possible to arrive at a measure of chemical affinity from determination of conductivity. It has indeed been already shown that the rate of change in the saponification of acetic ether is directly proportional to the conductivity of the liquid employed. Such wide-reaching inquiries into new and fertile fields, in which we seem to come into nearer touch with the molecular state of matter, and within a measurable distance of accurate mathematical expression, leads to confident hope that Lord Rayleigh's pregnant words at Montreal may ere long be realised: 'It is from the further study of electrolysis that we may expect to gain improved views as to the nature of chemical reactions, and of the forces concerned in bringing them about; and I cannot help thinking that the next great advance, of which we already have some foreshadowing, will come on this side.'"

Competition in Electricity.—The Cadiz Academy of Science gives as the subject for the public competition of 1887, "Electricity employed on board ships as a motive agent." The prize, consisting of two vases in bronze and marble, is given by the Infanta Isabel.

Sanitary Engineering at a Discount.—On the authority of the *Morning Post* we learn that the use of d'Humy's water battery involves a great sanitary advantage. The fluid flushed from the cells daily by the supply of fresh water is a slightly acidulated solution of iron, which is a high disinfectant, and most beneficial when discharged into drains.

Reception of Journalists in Manchester.—The journalists and scientific correspondents attending the meeting of the British Association were entertained on Wednesday evening by the members of the Manchester Arts Club, Albert Square. Sir Henry Roscoe and a large number of other gentlemen were present. Mr. J. H. Nodal, *Manchester City News*, proposed "the Press," to which Mr. W. A. Burn, *Times*, and Mr. William Senior, *Daily News*, responded. A pleasant social evening was passed.

Prof. Tyndall on Lightning Conductors.—Prof. Tyndall, writing to the *Times*, says: "Your recent remarks on thunderstorms and their effects induce me to submit to you the following facts and considerations. Some years ago a rock lighthouse on the coast of Ireland was struck and damaged by lightning. An engineer was sent down to report on the occurrence, and as I then held the honourable and responsible post of scientific adviser to the Trinity House and Board of Trade, the report was submitted to me. The lightning conductor had been carried down the lighthouse tower, its lower extremity being carefully embedded in a stone, perforated to receive it. If the object had been to invite the lightning to strike the tower, a better arrangement could hardly have been adopted. I gave directions to have the conductor immediately prolonged, and to have added to it a large terminal plate of copper, which was to be completely submerged in the sea. The obvious convenience of a chain as a prolongation of the conductor caused the authorities in Ireland to propose it, but I was obliged to veto the adoption of the chain. The contact of link with link is never perfect. I had, moreover, beside me a portion of a chain cable through which a lightning discharge had passed, the electricity in passing from link to link encountering a resistance sufficient to enable it to partially fuse the chain. The abolition of resistance is absolutely necessary in connecting a lightning conductor with the earth, and this is done by closely embedding in the earth a plate of good conducting material and of large area. The largeness of area makes atonement for the imperfect conductivity of earth. The plate, in fact, constitutes a wide door through which the electricity passes freely into the earth, its disruptive and damaging effects being thereby avoided. These truths are elementary, but they are often neglected. I watched with interest some time ago the operation of setting up a lightning conductor on the house of a neighbour of mine in the country. The wire rope, which formed part of the conductor, was carried down the wall, and comfortably laid in the earth below, without any terminal plate whatever. I expostulated with the man who did the work, but he obviously thought he knew more about the matter than I did. I am credibly informed that this is a common way of dealing with lightning conductors by ignorant practitioners, and the Bishop of Winchester's palace at Farnham has been mentioned to me as an edifice 'protected' in this fashion. If my informant be correct, the 'protection' is a mockery, a delusion, and a snare."

Our Correspondence Columns.—Two long letters have reached us, but too late for insertion this week. One, from Capt. Cardew, R.E., deals with the question of dynamo testing, and refers specially to Mr. Swinburne's article in our last issue; the other enters at length into the matter of insulating underground wires, and was evidently inspired by the series of papers on that subject recently published by us.

Submarine Cables in Costa Rica.—The *Manchester Courier* of the 31st ult. states that the Minister of Public Works in Costa Rica has entered into a contract with M. Cuenza Cruz, of Paris, for the establishment of submarine cables between the East Coast of Costa Rica and the East Indies, Venezuela, and New York. The contractor has also the right of laying down cables to such points in Central and South America as are not yet in telegraphic communication with Costa Rica. The contractor also engages to connect these cables with the line of Canary Isles, and the Government guarantees the minimum receipts to be 35,000f. per annum. The first cable must be laid in two years.

Electric Bell Tenders.—Estimates are required for fitting up the Union Workhouse at Pontypridd, Wales, with electric bells. Further particulars can be obtained from Mr. Spickett, Clerk to the Guardians, and tenders are to be sent in by the 6th inst.

Electric Lighting in Belgium.—An electric light installation of arc and glow lamps has just been completed in the colliery known as the Sacré-Madame, near Charleroi. The work has been executed by the Societé Electricité et Hydraulique, under the administration of M. J. Dulait. It comprises 12 arc and 250 glow lamps, the current being supplied by two slow speed Dulait dynamos, each giving an output of 250 ampères at 100 volts at 425 revolutions. Each dynamo is driven by a separate 35 H.P. steam engine. The dynamos are coupled in parallel by means of a switchboard where the current is divided into five circuits, each of which is served independently of the others.

Gas and Electricity at Tunstall.—At a recent meeting of the Tunstall Local Board a question arose as to whether the duties of the committee appointed to deal with the recent gas question would now be at an end, and whether the committee should longer exist. It was thought by some members that the committee should still continue. This was the opinion of the Chief Bailiff, who thought their duties were not yet quite at an end, for he intended to call a meeting of the committee at a suitable date for the purpose of hearing explanations from the electric lighting company, whose agent had recently visited the town, in respect to the use of electricity for illuminating the streets. This company was fully convinced that the electric light could be provided cheaper than gas in Tunstall. It was remarked that the electric light was said to effect a saving of 50 per cent. of the cost of lighting by gas, but one member said that he had been informed that at one place where the electric light was in use, there was no saving in the cost, but a decidedly better light was given, and the workers could work much longer with it than they could with gas light.

NEW COMPANIES REGISTERED.

London Electric Supply Corporation, Limited.—Capital: £1,000,000 in £5 shares. Objects: To supply electricity for lighting and other purposes within the City of London and the Metropolitan area, and for such purposes to enter into an agreement with Sir Coutts Lindsay & Co., Limited. Signatories: The Hon. R. T. D. Brougham, C.E., 15, Hans Place, 1,500 shares; the Earl of Crawford, 2, Cavendish Square, 3,000 shares; Francis Ince, St. Benet Chambers, 2,000 shares; Sir Coutts Lindsay, Bart., 11, Grosvenor Square, 12,000 shares; Joseph Pyke, Devonshire Place House, 6,000 shares; A. F. Wade, 9, Albert Mansions, S.W., 10,000 shares; Lord Wantage, 2, Carlton Gardens, 7,500 shares. The signatories are the first directors. Qualification: £5,000 of share capital. Remuneration: £2,000 per annum. Registered 26th ult. by Ashurst, Morris & Co., 6, Old Jewry, E.C.

Northern Electrical Engineering Company, Limited.—Capital: £25,000 in £1 shares. Objects: To take over the businesses of F. H. Perry & Co., Limited, of Victoria Street, Liverpool, and of H. I. Marshall & Co., of Custom House Arcade, Liverpool, scientific apparatus manufacturers and electrical engineers. Signatories (with one share each): T. M. Bigley, C.E.; J. E. Banks, R. H. Anderson, W. Ingham Marshall (electrical engineer); F. W. Witter, F. H. Perry (electrical engineer); all of Liverpool, and R. F. Johnson, 77, Stoke Newington Road, The signatories are the first directors. Qualification: 300 shares. Registered 26th ult. by Gregory & Co., 1, Bedford Row. Registered office, 36, Victoria Street, Liverpool.

Leete, Edwards and Norman, Limited.—Capital: £20,000 in £5 shares. Objects: To carry on business as engineers, tool and boiler makers, electricians, India-rubber and vulcanite manufacturers. Signatories (with one share each): *A. Leete, *W. Edwards, *H. C. Norman, C. W. Ray, of 366 and 368, Euston Road; *A. R. Reeves, Hendon; J. Leete, 11, Ashchurch Terrace, Shepherd's Bush; E. Mansell, Grassington, Beckenham. Directing qualification: £500 in fully paid shares. The signatories denoted by an asterisk are the first directors. Remuneration: £200 per annum.

Universal Electric Company, Limited. — Capital £50,000 in £5 shares. Objects: To carry on the business of an electric light company in all branches. Signatories (with 1 share each), C. Capito, M.E.; M. P. Haroz (electrical engineer), 63, Queen Victoria Street; E. Damiquet, 24, Rue Baudin, Paris; A. de Cavaillon, 24, Rue Baudin, Paris; Thos. Fardon, M.E., Luton; J. R. Marsh, Luton; W. N. de Mattos, 27, Leadenhall Street. The signatories are to appoint the first directors, qualification, 20 shares; remuneration, £200 per annum. Messrs. C. Capito, E. Damiquet, and A. de Cavaillon are appointed managing directors and engineers for 10 years, each at a salary of £100 per annum, to be increased to £300 per annum so soon as 5,000 lamps are in operation by the company, and in addition thereto they will be entitled to one-half of the surplus net profits after a dividend of not less than £15 per cent. per annum has been paid. Registered 29th ult., by Elmslie, Forsyth and Elmslie, 27, Leadenhall Street.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Exchange Telegraph Company, Limited. — The annual return of this company, made up to the 10th ult., was filed on the 24th ult. The nominal capital is £246,250, divided into 8,125 A shares and 16,500 B shares of £10. The whole of the shares are taken up, and £8 per share has been called upon the A shares, the B shares being considered as paid up. The calls paid amount to £48,000.

Akester Electro-Motor and Accumulator Company, Limited.—An agreement, dated 9th ult., filed on the 27th ult., relates to the purchase by the company from Mr. W. H. Akester of certain inventions and other properties for £3,000 in fully-paid shares of £1 each.

Dixon & Corbitt and R. S. Newall & Company, Limited (Wireworkers and Electric Cable Manufacturers).—The statutory return of this company, made up to the 16th ult., was filed on the 26th ult. The nominal capital is £120,000, divided into 6,000 ordinary and 6,000 5 per cent. preference shares of £10 each. The whole of the ordinary shares and 1,400 of the preference shares have been allotted, the full amount having been called up on the former and £4 per share upon the latter. The calls paid amount to £1,780 and unpaid to £3,020, upon the preference shares. The full amount is considered as paid upon 6,000 ordinary shares and 2,000 preference shares.

London Battery Company, Limited.—At an extraordinary general meeting of this company, held at the offices, 132, Southwark Street, on the 3rd ult., the following resolution was passed, viz.:—"That the articles of association be altered by substituting in article 71, between the words 'less' and 'shares,' the word 'forty' in lieu of the words 'two hundred.'" This resolution was confirmed on the 18th ult. and registered 24th ult.

Equitable Telephone Association, Limited.—At a meeting of this company, held at 75, Queen Victoria Street, on the 29th July, a special resolution was passed, appointing Mr. George Cockburn Warden a director, notwithstanding his being interested under the contract of 27th December, 1884, stated in the prospectus. The resolution was confirmed on the 15th ult. and duly registered on the 24th ult.

Electric Apparatus Company, Limited.—The annual return of this company, made up to the 23rd ult., was filed on the 27th ult. The nominal capital is £12,000, divided into 1,150 A and 50 B shares of £10 each. 375 shares have been allotted and the full amount has been called. The calls paid amount to £3,000, and £750 is considered as paid.

Crossley Telephone Company, Limited.—The annual return of this company, made up to the 25th ult., was filed on the 26th ult. The nominal capital is £100,000 in £5 shares, viz.:—5,000 A, 12,500 B, and 2,500 C shares. 607 A, 120 B, and 350 C shares have been taken up, and £5 per share has been called upon the A and C shares and £1 per share upon the B shares. The calls paid amount to £4,905.

CITY NOTES, REPORTS, MEETINGS, &c.

Manchester and District Edison Electric Light Company, Limited.

THE report of the directors states that the balance sheet, though showing only a slight improvement on the previous year's work of the company, confirms the opinion expressed by the directors at the last annual meeting, that the prospect of the work to be done in the future is more favourable. Applications for estimates of the cost of installing the electric light are more numerous, and the interest taken by the public is more practical than in former years, indicating that this system of lighting is coming more in favour the better it is understood. Since the last meeting of the company the directors have terminated the central installation in Mount Street, and consequently the heavy expenses in connection with that establishment, the lease of which expires in December, are practically at an end. The lease of the company's show room and offices also expires this year, and in seeking fresh premises the directors are actuated by a desire to reduce the present expenses of the show room, which as an advertising medium is not any longer necessary. The reduction in the expenses which the above changes will bring about will better enable the company to meet the great competition they have to encounter, and this, coupled with an anticipated increase of business, will no doubt place it in the power of the directors to make a much more satisfactory report next year. The value of the incandescent lamp patents held in the Manchester district by this company has been considerably enhanced by the judgment given in favour of the Edison and Swan United Company having been sustained in the Court of Appeal. The balance sheet gives £231 8s. 8d. as the profit this year; cash at bank and in hand, £750 11s. 9d. The following resolutions will be submitted to the meeting:—"That the capital of the company be reduced from £600,000, divided into 50,000 A shares of £10 each, and 10,000 B shares of £10 each, to £550,000 divided into 50,000 A shares of £9 each and 10,000 B shares of £10 each; and that such reduction be effected by cancelling capital which has been lost or is unrepresented by available assets to the extent of £1 per share upon each of the 20,000 A shares which have been issued and are now outstanding, and by reducing the nominal amount of all the A shares in the company's capital from £10 to £9 per share." "That the name of the company be changed to the Manchester Edison Swan Company, Limited."

Lancashire and Cheshire Telephonic Exchange Company, Limited.

THE sixth annual meeting of this company was held on Monday in the Memorial Hall, Manchester. Mr. Charles Moseley, chairman of the company, presided.

The Chairman, in moving the adoption of the report (which appeared in the REVIEW last week), said it was a source of satisfaction to the directors to have got through another year with such satisfactory results. The revenue showed an increase of nearly £10,000 on the previous year. The income from their trunk wires showed a considerable increase, and the tendency seemed to be growing to use the wires between long distance towns. The mileage of the company had increased during the year from 6,203 to 7,253, which was a proof that the telephone was a growing necessity; and the probability was that the mileage would go on increasing year after year. The number of messages sent over the wires during the year was 11½ millons, being an increase of half a million. The average cost of the messages was 1d. The company were now seeking to extend the radius of their operations. They contemplated making arrangements with the National Company for connection with Staffordshire towns in the same way as arrangements had been made with the same company for communication with Yorkshire, and before long it was hoped that their connection with the midland district would be complete. They also hoped to connect with the salt district, and with Chester and North Wales. Arrangements were being made with a view to the introduction of a new switching apparatus in Manchester, similar to the one which had answered so satisfactorily in Liverpool, and advantage was being taken of this opportunity to concentrate into one switchroom all the telephone wires at present dispersed over three separate switchrooms in different parts of the city. A reduction had been made during the year in maintenance charges of £300, and this notwithstanding the great increase in mileage. Against this there was an increase of £4,500 in the general expenses. The directors could assure the shareholders that this expense had been unavoidable, but there were reasons why it was not desirable to explain the matter further. Their relations with the Post Office continued in the same undesirable condition. The Post Office put the screw on in every direction. Since the commencement of the business the company had sent the cotton report to their subscribers, and now the Postmaster-General had forbidden this, and under penalty of losing their licence they had to submit.

Mr. R. Neill seconded the report, which was adopted.

Mr. C. S. Agnew moved the declaration of a dividend at the rate of 7 per cent.

Mr. Hoffgaard, in seconding the motion, asked if any move had been made by the company with a view to get communication with London.

The Chairman said the matter was a difficult one to deal with. Their own system did not extend beyond Lancashire and Cheshire, so that they could not initiate a demand for communication with London. In this matter they were in the hands of the parent company, and the parent company, he was sorry to say, had not shown itself very enterprising.

The motion was agreed to, and after some formal business the meeting closed.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 26th were £2,672 after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

CORRESPONDENCE.

Maxima and Minima Problems.

I should be obliged if any of your readers would tell me if the accompanying method of determining "maxima and minima" is contained in any algebra. It applies to all cases where the equation is a quadratic. The principle is this :—

In every quadratic, where x is the unknown and y the known, there are two values of x to one value of y. Consequently, the curve representing a quadratic is always of the kinds shown in figs. 1 and 2.

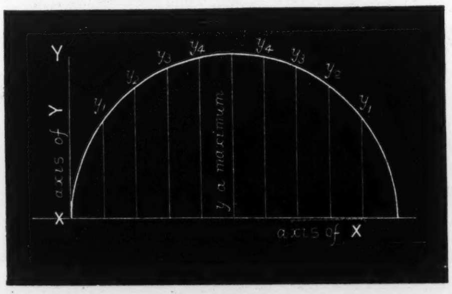


FIG. 1.

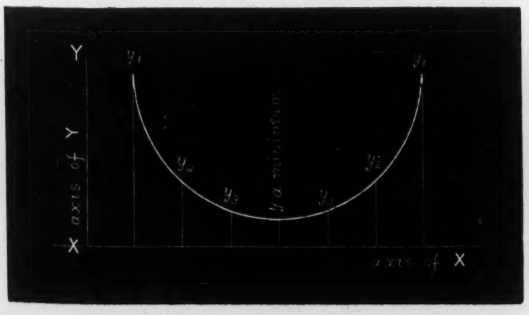


FIG. 2.

From inspection of the curves it is seen that when y is a maximum (fig. 1), or a minimum (fig. 2), there is only one value of x. We may therefore work out the equation by ordinary algebra, and write that part of the general value of x which would give x two values, as equal to nothing; and say that the value of x, which makes y a maximum or a minimum, is the other part. *E.g.* Let $x^2 - a\,x = y$. Where a is some constant, x a variable, and y a function of x. To find what value of x makes y a minimum :—By ordinary algebra,

$$x = \frac{a}{2} \pm \sqrt{y + \frac{a^2}{4}}. \qquad \text{(A)}$$

But, when y is a minimum, there is only one value of x, consequently

$$\pm \sqrt{y + \frac{a^2}{4}} = 0,$$

and $x = \frac{a}{2}$ makes y a minimum.

F. A. Harris, A.S.T.E.

21*st August*.

[We are not aware that the method described by our correspondent has ever been published in the particular form he gives it, but it is practically identical with the following, which, we believe, is pretty generally known (it is used throughout Kempe's "Handbook of Electrical Testing" for solving problems involving the determination of maxima and minima) :—

$$x^2 - a\,x = y,$$

therefore

$$\left(\frac{a}{2} - x\right)^2 - \frac{a^2}{4} = y\,; \qquad \text{(B)}$$

to make y a minimum by variation of x, we must make $\frac{a}{2} - x$ a minimum, that is we must make

$$\frac{a}{2} - x = 0$$

or

$$x = \frac{a}{2}.$$

Equations (A) and (B), it may be remarked, are identical.—EDS. ELEC. REV.]

Evolution of the Telegraph.

The interesting articles which have lately appeared in your journal on the above subject have raised so many ghosts which were quietly slumbering in their graves, that an old enthusiastic electrician may perhaps be excused for sending you a somewhat gossiping communication in which he proposes to chiefly confine his remarks to needle telegraphs.

In all applications of science to economical uses, they are several stages. There is—

1.—The incubation and scientific realisation.
2.—The sentimental and experimental stage.
3.—The constructive and less experimental period.
4.—The mathematical stage.

There is always a large chasm to be bridged before the developments of science become of any real value, the pioneers have to organise an entirely new industry, to discover new material not in the market, to create new tools and apparatus, and to encounter difficulties which have to be grappled with and overcome before any step forward can be made.

The names of Wheatstone and Cooke will always be honourably associated with a good deal more than the evolution of the telegraph through the first stage, but the burden of the second stage in this country fell in a large degree on Mr. Hatcher, the first chief engineer, and his assistants, Messrs. Holmes, Physic, and others.

The third stage for which the way had now been prepared was carried through by the practical engineer, who, although he kept in view the scientific aspect of telegraphy, regarded it in a larger degree from the shareholder's point of view as a commercial organisation, the primary object of which was to earn dividends.

The third stage I consider to have been initiated, and to a considerable degree carried through, by Edwin Clark, followed by Latimer Clark and his successors, all of whom have left their handwriting more or less indelibly written on the edifice of telegraphy.

The fourth, or mathematical stage, did not commence until after a complete edifice had been raised. In practical applications of science the mathematician, as a rule, waits until an edifice has been erected, he seldom attempts to originate, and when he does do so, as far as my observation goes, he as often as not makes mistakes.

In the case of telegraphy the materials for making the bricks were discovered, the bricks made and a complete building erected before the mathematician had anything valuable to say, not only was this so in overland telegraphy in the advancing of which the hand writing of the mathematician is not to be seen, as far as I can charge my memory, but it was also the same with submarine telegraphy, which involved problems in a greater degree requiring for their solution a true conception of the established laws of electrical science.

I ought, perhaps, make one exception, but this exception seems to me to prove the rule—I refer to the mirror instrument of Prof. Thomson. It was this instrument, and this instrument only, which enabled the mechanically successful, but electrically moribund Atlantic cable of 1858 to speak at all, and this was a practical telegraph advance of the very highest importance.

After the total failure of the 1858 cable the work of the mathematician became increasingly valuable, but the solution of the mechanical portion of the problem, with which the name of Sir Samuel Canning will always be associated, and the improvements in the manufacture and manipulation of gutta-percha, that so greatly increased its insulating properties, which were effected by the persevering labours of Willoughby Smith, were as important contributions to submarine telegraphy as that of Sir William Thomson, C. F. Varley, and Fleeming Jenkin, who worked in conjunction with one another.

Permit me to say a word also for myself. It was my privilege to be the superintendent of the first field telegraph used in war, and on my return from the East at the latter end of 1856, I found the subject of Atlantic telegraphy engaging the attention of our scientific men.

I attended the meetings of the Institution of Civil Engineers in 1857 and 1858, when papers on submarine telegraphy were read and discussed.

Regarding science, as I always have done, as being based on common sense reasoning, I was simply astonished at the conclusions which I learned had been arrived at by the scientific advisers of the first Atlantic company, and I was surprised to find these views receiving the support of practical as well as scientific men, including, as I afterwards learned, even Faraday himself.

The conclusions come to by the scientific advisers of the company were that for submarine circuits conductors of small sectional area transmitted messages more rapidly than those of larger sectional area.

Rather than allow such views to go forth unchallenged, whilst the papers of 1858 were being discussed I drew up a paper on the "Electrical qualifications requisite in long submarine cables," which was read before the Institution, in which I demonstrated the fallacy of the then prevailing views. No one at the Institution of Civil Engineers ventured to break a lance with me; but Cyrus Field accused me of going in the face of Faraday, and of being a "young man."

I followed my first paper by a second one, read before the Society of Arts in 1859, in which I showed the bearing of the laboratory investigations of the laws of electricity to submarine telegraphy, and, among other things, suggested the use of artificial submarine circuits for solving the problems of submarine telegraphy, and described the construction of one I was then making.

But to return to the more immediate subject of this communication, during what I have termed the sentimental period the working parts of the telegraph instruments were treated with reverence and respect, and were enshrined in elaborately designed models of Grecian temples, which gave an air of mystery, and inspired the beholder with awe and admiration for what at that period was regarded as so wonderful an invention.

Now whether it was the novelty of the invention, the architectural proportions of the instruments, or the fact that there were two handles, which being grasped by both hands balanced the operator, and made the instrument comfortable to work, I cannot say, but the feeling with which the double-needle telegraph was regarded was altogether different from any other instrument since introduced.

All the telegraph instruments of later date, including the single needle still largely used, have been regarded simply as apparatus designed for transmitting messages, but with the double-needle telegraph this was not so. There was a kind of personal relationship subsisting between the operator and his instrument, which he seemed to regard in some sort as an extension and part and parcel of himself.

Novelty, doubtless, had something to do with the feeling, but I think it arose in a greater degree from the imposing appearance of the earlier instruments, the ease and comfort with which they were worked and the new sense of power which they gave to the operator.

The generation born since the introduction of the telegraph look upon communication between places distant from one another as a matter of course, and in many cases, I fear, the chief feeling is one of injury that they have to pay 6d. for sending a message, but it was different in the earlier days.

There must be many still living who, like myself, have not altogether forgotten the feelings with which the introduction of the telegraph was hailed.

For my part, I confess that I consider it a good deal more than a poetic fancy to regard the telegraph wires as an extension of the nerves. Harmony runs throughout all nature, and even inertia, which is perhaps the most distinctive attribute of matter, has its analogue in electricity, the most refined of all the forces.

It is a universal law for higher organisations to prey upon and utilise the lower ones, and man lives on his brother mammals. It seems to me to be only in harmony with this law that we should hold communion with matter through the medium of the highest force associated with matter.

Long overland lines of telegraph where the messages are received and automatically sent forward by the succeeding translating stations, seem to me to be the conversion of our earth into something resembling those lower animal organisations where the brain and nervous matter is not so much concentrated as in the higher types of animal life.

The telegraph instrument is, after all, simply an electromotor which repeats the motions of the operator.

The operator's motions are controlled by his brain and are performed by the consumption of energy, but the force conveyed through the wire which causes the instruments to repeat the motions of the operator is derived from batteries situated at the ends of the telegraph sections. These batteries always appear to me to resemble and to perform similar functions as the ganglions of nervous matter of the centipede, for example. These ganglions in the centipede are located at regular intervals along the spinal cord and control the movements of those parts of the insect which are distant from the head and which, when set into action by the brain, continue to act for a time independently of it.

When I commenced this letter it was my intention to have confined myself in a greater degree than I have done to the evolution simply of the needle telegraph, but I have allowed my thoughts to run away with me to such a length that I must bring this communication now to an end. There are, however, matters connected with its evolution which I should like to direct attention to, and if your columns are open to me I may be tempted at some future time to return to the subject.

S. Alfred Varley.

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